encouraging business ventures in space technologi

"Partnership between the U.S. private sector and the U.S. government will . . . develop a major new industry . . ." President Rea

Report by a panel of the
National Academy of Public Administration

Prepared for the National Aeronautics and Space Administration (NASA)

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Also incorporating Congressional testimony of Philip M. Klutznick, James M. Beggs, and Daniel J. Fink

National Academy of Public Administration

Preface

This report, prepared by a Panel of the National Academy of Public Administration, presents the findings of a study initiated at the request of the National Aeronautics and Space Administration (NASA). The issues analyzed in this investigation concern the relationships between the public and private sectors in the commercial utilization of the space environment and the requirements of a policy framework conducive to business ventures based on space technologies.

The major audiences being addressed in this report are the business and government leaders who will make the decisions determining the nature and extent of America's future in space. In the business community the major audience consists of executives involved in strategic planning, the search for new business opportunities and the overall direction of research and development programs. The public sector audience includes both those executives in NASA who deal on a day to day basis with industry proposals for commercial initiatives and those in other executive branch agencies and the Congress who are now seeking to resolve some of the complex questions posed by the prospects for business ventures in space technologies.

The issues prompting NASA to request the study arose from the novel circumstances leading to the stated policy of the Federal Government to encourage private investment in space enterprises. However, the specialized concerns addressed here are an important part of a more general dialogue regarding the search for business-government relationships favorable to technological innovation and the renewal of American competitiveness in global markets. A major theme emerging from the Panel's deliberations is the need for business and government teamwork in rebuilding and exploiting the research and development capabilities of the United States.

The Panel's report was the subject of hearings held on May 3, 1983, by the Subcommittee on Space Science and Applications of

the Committee on Science and Technology of the U.S. House of Representatives. The three principal witnesses were Philip M. Klutznick, Panel Chairman; James M. Beggs, NASA Administrator; and Daniel J. Fink, Chairman of the NASA Advisory Council. The hearings were an important landmark in bringing the results of the Panel's work into public view and in demonstrating the endorsement by the NASA Administrator and Mr. Fink, speaking in his capacity as an experienced aerospace industry executive, for the findings and recommendations of the report. The statements of the three witnesses are attached as the final appendices.

This report follows ten other studies conducted by the Academy at the request of NASA over the past decade on critical management, administrative and organizational issues confronting the agency. A list of these earlier reports appears on the back cover of this report. Like the present investigation, most of the previous studies were the product of Academy panels supported by professional staff.

Those chosen to serve on the Panel for this study brought to it a unique mix of experience and knowledge gained in distinguished careers in business and government relevant to the Panel's task. The majority of the panelists have occupied senior managerial positions in business representing a range of perspectives and insights on the corporate decision-making process.

The Panel has met on six occasions over a six month period to review the complex array of issues, to analyze the literature on the subject and to obtain the views of key figures in NASA, other federal agencies and the private sector. Extensive interviews conducted by the Panel staff were reported to the Panel as background information on the views of knowledgeable governmental and business executives. A succession of draft reports reviewed by the Panel has culminated in the final product.

As the study was being launched, the Administrator of NASA, James M. Beggs, formed a task force of senior NASA officials having principal interest in the concerns of the study to interact with the Panel. The interaction with this task force has taken the form of joint meetings with the Panel and individual consultation with task force members concerned with particular aspects of the study. This device for involving NASA officials in the work of the Panel has provided effective support for the Panel's efforts.

The Academy is indebted to all those who contributed to this

endeavor. The Panel chairman, Philip M. Klutznick, generously devoted time and personal commitment throughout the undertaking. Other panel members were Stover L. Babcock, Jr., Richard H. Bolt, Samuel M. Cohn, Emilio Q. Daddario, Harold B. Finger, Peter G. Goldmark, Jr., John A. Johnson, Gerald J. Mossinghoff, Mitchell Rogovin, and Thomas O. Paine. Project teams from seven companies met with the Panel to describe their proposed initiatives and to discuss the opportunities and problems associated with their respective ventures. The support received at all levels of NASA, especially the Office of Technology Utilization and Industry Affairs which served as the agency monitor of the effort, was indispensable to the work of the Panel. Ronald J. Philips, the director of that office, and Stanley R. Goldberg, the NASA project manager, as the principal NASA links to the Panel, provided continuing support to the effort.

Gerald Mossinghoff, the United States Commissioner of Patents and Trademarks, prepared the appendix on intellectual property. Milton Carrow of American University, working in association with the Panel Vice Chairman, Mitchell Rogovin, served as a consultant to the Panel on antitrust issues. Jean Guard Monroe served as technical editor of the report.

* * *

Finally, I want to acknowledge the dedicated efforts of the Panel staff. Erasmus H. Kloman, Senior Research Associate of the Academy, served as Project Director drawing on his experience in a similar role on numerous other Academy studies. Craig Voorhees, as research associate, brought to the project the in-depth familiarity with the space program gained from extensive service on the Senate authorizing committees. Debra Kearse provided valuable secretarial support and a cheerful attitude throughout the project.

—J. Jackson Walter
President

Foreword

The United States embarked on its voyage of discovery in space mainly in recognition of early Soviet accomplishments in space and the need to attain a U.S. leadership position in the exploration and use of this new frontier. The American people have already earned enormous benefits from the great achievements of those who have made the space program one of man's great technological triumphs.

Other considerations that prompted the decision to explore this new frontier were the desire to expand scientific knowledge of the universe and the prospect of economic benefits. The value of the scientific knowledge acquired to date is beyond quantification. Furthermore, if we look only at the economic impacts of the space program, which are the focus of this study, we observe that many important economic gains have already been scored, two notable examples of which are the creation of the communications satellite industry and the many advances in space-related computer technology which have been applied to civilian uses.

The importance of maintaining a United States leadership position in space is so great that the nation must continue its activities on this frontier without counting on further substantial economic side effects or benefits. At the same time, it is increasingly evident that the role played by the private sector up to now in strong support of the government's program has opened up promising vistas of opportunity for the private entrepreneur. While these opportunities may be seen as a by-product, it is clear that, by assuming a larger role through commercial ventures in space, private entrepreneurs can provide an enormous assist to the maintenance of the United States leadership in space.

At a time when our nation has suffered losses in areas of technological creativity where it was once the undisputed leader, the space program has provided a compensating stimulant, the tempo of which must not be lost. The prospect for business ventures in space

technologies represents a major opportunity to demonstrate that within the free enterprise philosophy there is a great potential for cooperative endeavor between the public and the private sectors. Pursuit of this opportunity could become a model for joint public/private efforts in other areas.

—Philip M. Klutznick
Chairman
Panel on Encouraging Business Ventures in Space Technologies

Summary

Within the past quarter century the United States has penetrated the frontier of space exploring even distant reaches of the solar system. The space program, born of national resolve and financed by the American people, has opened the space environment to the scrutiny of mankind.

Spurred by fears of vulnerability to the Soviet presence in space, the United States inaugurated a space program that has yielded substantial benefits to the nation. A major goal of our national space policy today is to maintain the position of U.S. leadership in space. Now, moreover, we begin to see emerging possibilities for private industry to use space technology and the space environment for new commercial ventures. The resulting business could serve to strengthen the economy, expand employment and improve the nation's posture in the global competition for high-technology markets.

The extent to which past investment in space technology contributes to our future economic well-being and national growth will depend in large measure on policies and actions taken in a spirit of collaboration by the Federal Government and industry. Unless the public and private sector join to develop the opportunities presented by new space technologies and unless entrepreneurial forces are engaged more fully, the United States will fall behind in the contest for leadership in space and the economic rewards associated with that position.

The Panel recommends the following policies and initiatives for adoption by NASA to encourage business ventures in space technologies:

1. *Declare and institutionalize a major commitment to the commercialization of space technology.*
   - Make a clear statement of commitment to commercialization as a policy of NASA, and announce the policy

widely within NASA and throughout the government and the public.

- Establish within NASA a well defined, top-level management focus for the commercialization of space technology.
- Present the case for commercialization within the government, and offer advice and assistance to entrepreneurs seeking guidance in complying with applicable governmental requirements.

2. *Assist industry in pursuing opportunities for profitable investment in space.*
   - Develop mechanisms, including collaboration with the Department of Commerce, to establish relations with all segments of American industry that could play an effective role in commercializing space technology.
   - Encourage the private sector, including small and new companies, to seek opportunities in applying space technology, as a promising investment of their effort and risk capital.
   - Identify new requirements for services and products that need not be developed as a traditional NASA controlled and funded development, and publicize the requirements as offering opportunities for private endeavor.
   - Adapt experience gained in the government/industry advisory and experimental relationships in NASA's aeronautical research programs to the commercialization of space technology.
   - Use and expand NASA's Technical Exchange Agreement and Industrial Guest Investigator program to promote exchange of information between industry and NASA.
   - Make the fullest possible use of the Joint Endeavor Agreement and other innovative mechanisms to help increase the usefulness and decrease the costs and risks of space transportation and other NASA facilities.
3. *Offer NASA facilities and services for use by private companies under conditions that encourage commercial development.*
   - Consider facilities such as the space shuttle and any future space station to be national resources available for use in

commercial efforts, under explicit conditions, toward national economic benefit.

- Make launch services as predictable and reliable as possible, in order to permit sound business planning and investment.
- Respond promptly and affirmatively to proposals for commercial operation of expendable launch vehicle systems (ELVs) under guarantee by the commercial operator to fulfill all existing United States Government commitments for launch services by those ELVs.

4. *Continue R&D including study of long-range opportunities.*
   - Undertake R&D to provide unique research and operating capabilities too costly or technologically complex and advanced for private investment.
   - Pursue NASA R&D in satellite communications and other space applications technologies relevant to United States leadership.
   - Increase the emphasis on all aspects of the NASA program of materials processing in gravity-free conditions.
   - Recognize that full commercial exploitation of space will need to involve private transportation facilities, and consider long-run potentials in judging proposals for private financing and marketing of space vehicles, even if the proposed plan is not feasible now.
5. *Reduce the risks and restrictions that impede commercial exploitation of space technologies.*
   - Continue flexibly using authority to accord full rights in inventions and proprietary information to private parties in joint endeavors.
   - Continue to keep informed on needs for insurance to protect against risks and work closely with the insurance industry, but do not put NASA in the insurance business.
   - Encourage simplification of federal regulations for space launch systems and associated payload activities, and provide technical advice but avoid placing NASA in the role of regulating commercial activity.
   - Advocate commercialization within the Senior Interagency Group on Space and the promulgation through the SIG of

criteria for determining the national security acceptability of proposed ventures.

In requesting this study NASA identified a need for a clear set of guidelines for evaluation of commercialization proposals submitted to NASA. The final section of this report suggests general principles to govern this process along with policy considerations and specific requirements to serve as a basis for determining the NASA response to private initiatives.

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Introduction

During the late 1960s and 1970s large sectors of the American economy did not perform well. The requirements of modern technology and contemporary markets marked a shift from a world where historical American dominance in high-volume, standardized mass production guaranteed a strong and competitive American economy.

The implications for the United States of the emerging world economy appear to include the need for:

- rapidly evolving and diversified technologies;
- flexible teams organized to design and manage complex systems rather than to define and manufacture fixed products;
- goods and services that can command overseas markets.

In all these respects the aeronautical and space industries have been excellent performers during an uneven period in American economic history. The programs of the National Aeronautics and Space Administration (NASA) and related Department of Defense (DOD) undertakings have fertilized and seeded a broad spectrum of companies, helping to keep American industry competitive. These activities encourage and demand the kind of task-oriented, flexible teamwork and management necessary for high productivity and effective performance in the world economy.

As NASA turns to commercialization of space, therefore, it is necessary for NASA and the entire government to take full cognizance of the constructive and catalytic role space efforts can play in sustaining the technological and economic competitiveness of large sectors of American industry. In explicit recognition of that responsibility it is also necessary to define national policies so that this catalytic role can be sustained and expanded.

Thus the central focus of this inquiry is how to engage the creative skills and entrepreneurial initiative of the private sector in the exploitation of space technologies. Many issues have been explored

by the Panel in its search for answers to this central question. The Panel has examined the overall relationship between government and business, the process whereby decisions on investment of risk capital are made, the existing structure and mechanisms through which NASA seeks to encourage private initiatives, the growing number of private space technology ventures in various stages of development, and the increasing activity evident in Japan and Western Europe where national governments are targeting specific space technologies for development.

From the outset of this endeavor it has been apparent to the Panel that the national interest is closely related to maintaining the position of U.S. leadership in space. As the study has progressed, the Panel's awareness of the significance of this leadership position has intensified. At the same time, the Panel has become increasingly conscious that maintaining this position depends on engaging the private sector, while continuing strong support for the government's space program.

In discussing the prospect for commercialization of space it is essential to distinguish between the various classes of commercial applications. There are several ways in which such applications could be categorized. Some applications relate to launch systems or services, such as proposals to commercialize expendable launch vehicle (ELV) systems or shuttle-based projects. The special characteristics of these space transportation enterprises are discussed in Section V.

Other commercial applications, not associated with launch systems, cover a wide range of products and services. Some of these offer support to spacecraft while others are intended to meet consumer needs. In the first category are projects such as spacecraft processing (or the integration of payloads and spacecraft), leasing on-orbit spacecraft facilities, repair/maintenance of satellites, satellite tracking and command/control services. The second category, consumer-oriented applications, includes communications satellites, remote sensing, materials processing and various promotional enterprises. A complete catalogue of commercial enterprises would include a category covering a variety of goods and services from space-based technologies yet to be conceived.

The distinctive attributes of these three classes suggests that generalizations about space commercialization can be misleading.

The opportunities for investment in these different types of enterprise will interest different entrepreneurs and investors. The size and conditions of the investment involved will vary greatly from one area to another. Nevertheless, there are important factors in common among the three market areas. While the discussion which follows takes account of these differences, it concentrates on the points in common and the need for creating a climate conducive to investment.

I

Maintaining United States Space Leadership

The National Space Policy of July 4, 1982, sets out as one of its basic goals "to maintain United States space leadership." (See Appendix 2.) Entering the space age, the United States and the Soviet Union were the only two contenders for that leadership, and both maintain strong space programs today. Moreover, other industrial nations in the non-communist world have stepped up their own space programs. Among the industrial democracies, the United States still holds a commanding lead in its overall space capabilities as exemplified by the great transportation flexibility afforded by the shuttle.

Benefits of the Space Program

The impetus for United States activity in space has been essentially threefold—to safeguard national security, to increase scientific knowledge of the universe, and to accrue economic benefits. All three are closely interrelated. However, since the Panel's mandate is focused primarily on the third goal, this report deals mainly with economic concerns. The civilian space program of the United States represents an expenditure of about $100 billion. Past support for this public investment has assumed that it would yield a significant return to the economy along with major advances in scientific knowledge and technical information of value to the military space program. Indeed, very high economic returns have already been realized through the beneficial effect of the civilian space program on innovation and product development in a number of high tech-

nology industries such as data processing and telecommunications.

A principal benefit to be gained from continuing strong support for the United States civilian space program is the further strengthening of the competitiveness of our economy. Increasing levels of activity by private investors in space technology ventures suggest that the nation may be on the verge of realizing further economic benefits. Estimates of the value of goods and services to be produced from space are at this point necessarily conjectural. Besides the thriving communications satellite industry, most other privately financed space technologies are still in a developmental stage. However, the Panel believes that there is a very real opportunity for increased commercial enterprise based on space technologies. New products or services, productivity improvements and other national benefits from scientific advances can be achieved. The realization of that potential will depend in great measure on joint efforts by the Federal Government and the business and financial communities to carry out the commitment in the National Space Policy "to expand United States private sector investment."

Adverse Consequences of Loss of Leadership

Another way of looking at U.S. space leadership is to ask what adverse consequences would ensue from a substantial erosion of that leadership. In the first place, it is apparent that U.S. national security and geopolitical interests would be jeopardized by allowing the Soviet Union to surpass the United States in key space applications. Recent substantial increases in the U.S. military space budget are a recognition of the importance of national security considerations.

Any significant reduction of U.S. efforts will also have adverse effects on space sciences research. NASA's scientific programs represent a precious national asset. They contribute to man's ability to understand his environment and the Earth's place in the universe. They are essential to promote the intellectual vitality of American science. They provide a knowledge base from which to advance both civilian and military space technologies.

The adverse consequences of failure to maintain the U.S. position in space would be felt acutely on the economic front. U.S. aerospace exports in 1982, for example, amounted to $15.6 billion. The Western European nations, especially France and Germany, and

to an even greater degree, Japan have entered into keen competition with the United States in a number of high technology areas that they have targeted as commercial priorities. Given U.S. policies of sharing information derived from our space program "for the benefit of all mankind" it is reasonable to expect that other nations would develop their own capabilities in competition with our own.

Impacts of Foreign Competition

One of the major goals of the National Space Policy is to "promote international cooperative activities in the national interest." Certainly international cooperation has helped to advance U.S. programs as illustrated by the $900 million financing by the European Space Agency of Spacelab as an integral component of the U.S. space shuttle system. Nevertheless, it must be recognized that the U.S. economy is suffering severely from the erosion of its once dominant position in high technology areas as a result of the impressive gains by Japan and Europe in such fields as electronics and communications. While the individual space budgets of these foreign competitors remain below U.S. levels, they have significantly increased their public expenditures for space programs in recognition of the benefits of such endeavors to the strengthening of their national economies. Their space programs are viewed as an impetus in their overall efforts to compete in high technology areas.

Western Europe and Japan's tradition of government-business partnership is a major factor in the increasing competition with the United States. The European nations have a long history of sponsoring cartels to gain the greatest possible share of world markets. In Japan, the Ministry of International Trade and Industry (MITI) is a dominant feature of that nation's successful efforts to promote a strong economy through job creation and exports. MITI, as an arm of government, exercises great influence in determining where Japan will focus its efforts and which industrial firms will be the chosen instruments for collaboration in developing new markets at home and abroad. MITI concentrates its resources in the strategic areas of microelectronics, including robotics; biotechnology; new materials, such as ceramics and carbon fibers; and optical fibers for communications equipment. The Japanese space agency, NASDA, spearheads national efforts in targeted areas of space technology.

In the United States there is also a record of government working with and subsidizing the private sector in selected areas. Federal land grants to the railroads in the 19th century and support to the airline industry in its formative years are notable examples of this tradition. More recent examples are found in the stimulating effects on the computer industry of procurements by the DOD and NASA and the partnership between the aviation industry and the National Advisory Committee for Aeronautics (NACA) and its successor agency, NASA.

Over the 25 years of its existence approximately 90% of NASA's annual research and development (R&D) appropriations have been spent in contracts with industry and various forms of financial support of academic research institutions. During the first half of this period NASA funding was a major factor in developing the capability of American educational institutions to train technicians and engineers for the rapidly evolving technologies of space.

Nevertheless, any comparison of NASA or other parts of the Federal establishment with European or Japanese approaches to competition for global markets reveals that similarities are greatly outweighed by significant differences. The U.S. commitment to the competitive enterprise system is inconsistent with a centralized planning system or industrial policy through which the government sets production priorities, targets industrial sectors for special emphasis and subsidizes the private participants in selected enterprises. The American economic system is based on belief in the principles of private enterprise and the force of competition as the most effective means of promoting economic well-being. There is, however, growing recognition that teamwork and cooperation often produce more positive results than the sometimes adversarial relationship characterizing labor-business-government relations in the United States.

Some statistics comparing United States and Japanese performance during the past two decades illustrate trends which are changing their relative positions. In 1962 the United States' share of industrialized country high technology exports was 30.3 percent; by 1980 it was 23.9 percent. Japan's share grew from 4.1 to 12.3 percent. Japanese R&D expenditures as a percentage of gross domestic product rose from 1.5 to 2.0 percent between 1964 and 1979, while it fell from 3.1 to 2.4 percent in the United States. In absolute

terms, of course, the size of United States R&D expenditures is far greater than those of Japan.

In some respects, however, the Japanese have more flexibility in discretionary research than the United States. The U.S. military umbrella that has relieved Japan of so great a share of its responsibility for funding its own national security program has allowed Japan to select targets of opportunity for R&D activity. As defense and other requirements associated with the world leadership position of the United States have increased, the discretionary share of R&D funds has diminished. Furthermore, the United States as a world leader must finance R&D across the entire science and engineering spectrum to avoid missing any areas of opportunity; Japan and other nations can examine the results of these initiatives and concentrate their own efforts on those areas offering the greatest industrial potential. The concept of teamwork or partnership, as exemplified in the early NASA experience, deserves increasing emphasis in American efforts to protect the nation's position in the increasingly intensive competition for high technology markets.

II

The Private Entrepreneurial Role

The United States relies on private enterprise as the driving force of its economy. Government is not viewed under most circumstances to have a role as a producer or marketer of goods or services. Recent years have brought renewed recognition of the importance of the entrepreneur as the generator of innovation, greater productivity and growth. Interestingly enough, this recognition transcends party lines and is reflected, albeit with varied responses, on both sides of the political aisle. The high technology enterprises of the future will call for a wide range of entrepreneurs. In some instances they will be large established companies; in other cases individuals or small groups will try to enter into new high technology ventures. All types are needed to develop the commercial potential of space.

Small entrepreneurial ventures in high technology markets such as electronics and communications are demonstrating increasing ability to develop innovative ideas into profitable enterprises. These firms enjoy greater flexibility than most larger established corporations. They are responsible for an important share of new jobs especially in high technology industries. In comparison with larger companies, however, the small firms are more burdened by the administrative, legal, financial and regulatory complexities involved in dealing with the Federal Government. Small firms often lack the experience and resources needed to make their way around in Washington and in the NASA bureaucracy.

The advantages enjoyed by larger firms in dealing with NASA and other parts of the executive establishment point to the need for an evenhanded policy in considering private sector commercial-

ization initiatives assuring that there is no discrimination against smaller firms.

Risk-taking in Space

The hallmark of private enterprise is the placing of capital at risk. With some notable exceptions most of the great achievements of the American economy have resulted from the willingness of private investors to invest in creative ideas. The process for deciding what ideas will succeed in the marketplace has become increasingly sophisticated as technological, financial and marketing factors have become more complex.

Capital risk-taking in space would seem at first glance to be even riskier than ground-based ventures. Indeed it seems to require either a past familiarity with space technologies or a special pioneering spirit to engage entrepreneurs in this arena. Even so the Panel has observed that a significant number of private companies are either already embarked or preparing to embark on one of the several types of commercial applications described above.

As with more conventional ground-based enterprises, the success of these new space-based ventures will depend on the rigor of the process leading to a go/no go decision on investment. Just as that process has been a critical factor in shaping and building the great domestic economy of the United States, so is it essential to America's future in space. Hitherto, the Federal Government has played the lead role in funding and directing both civilian and military space programs. Although NASA's budget in the past two years has increased slightly, it seems unlikely that the high budget levels of the 1960s will be resumed. In order to retain the momentum of the past and to maintain the economic competitiveness of the United States in space technologies, the private sector will have to become increasingly involved both as provider of risk capital and as innovator of enterprises with the potential for profit.

Phasing NASA Out of Operations

The great contribution of NASA to American society and the world at large has been made by continuously advancing the state of the art of space technologies. Through its unique approach towards advanced research and technology, NASA has performed the most

challenging missions to place the United States in a leadership position in space. NASA management both in Headquarters and the field has generally been extremely selective about the assignments they would undertake. Once knowledge has been gained about how to produce a piece of hardware and make it function, the value of the learning experience from repeating the task diminishes.

Thus NASA has refrained wherever possible from engaging in repetitive operations, preferring to concentrate on new R&D initiatives. When it has proven feasible, as in the case of communications satellites, NASA encouraged the private sector to take over, thus reserving its talents for other priorities. At the present time, NASA is phasing out of the operation of two major expendable launch vehicle systems which may be commercialized, and is looking ahead to the time when commercial operation of the shuttle may become feasible. Other opportunities for commercialization of products and services in support of spacecraft and for public consumption are also under active consideration.

In any institution undergoing change there is a tendency to perceive the phasing out of functions as a diminution of the institution's responsibilities. In fact, however, the commercialization of enterprises in space will add to, rather than detract from, the need for NASA's research and technology function. As the number of commercial enterprises in space increases, there is likely to be a corresponding increase in the requirements for the kinds of basic and applied research for which NASA is uniquely qualified.

III

The Several Roles of NASA in Support of Commercialization

NASA has been and continues to be a mission-oriented organization, a factor that contributes significantly to its successes. This concentration on specific objectives focuses efforts, identifies research and development needs, and presents challenges for accomplishment. The benefits of this approach while apparent in highly visible achievements are also to be found in the broad research and technology base that has been established. NASA should strive to maintain this approach. In addition to the technology gains, such an approach is essential to attracting, stimulating and retaining the high caliber scientific, engineering and management personnel required to undertake the high technology endeavors inherent in space exploration and exploitation. Further, a strong advanced R&D activity is the best counter to any perceived threats to the institution or its people that may emanate from a concurrent commercialization thrust by the agency.

Development of Unique Capabilities

There is a distinct role for NASA in the space commercialization process. First and foremost, NASA has developed the basic space flight transportation capability in the form of the expendable launch vehicles and the space shuttle, a capability most unlikely to have ever been initiated by the private sector. It has demonstrated that man can live and perform useful work in the space environment. It has developed and demonstrated the technologies for communications, meteorological and land remote sensing satellites. Finally,

it has conducted experiments in materials processing and other research in many high technology areas.

The space shuttle has demonstrated its commercial satellite launch capability from low earth orbit. However, its many other capabilities which are essential to commercial initiatives remain untested. Manned extravehicular activity (EVA) must become routine. Accomplishing the EVA objective, and learning to use and expand the shuttle's capabilities are functions only NASA is equipped to perform. Devices for supporting experiments and subsequent operations in materials processing, for example, are yet to be developed; there is also a need for additional lower cost electrical power on orbit. Space station studies are presently underway in NASA. In the longer term, it can reasonably be expected that more efficient transportation systems will become technically feasible.

The space shuttle, its derivatives, and a space station are not only multi-user facilities but also are very large, high-risk investments beyond the financial capability of individual companies. *Such facilities should be viewed as a national resource which, although developed by the government, provide research and operational capabilities the results from which can be exploited within clearly developed principles by private sector organizations for their own interests and for national economic benefit. The use of these facilities by the private sector should be encouraged by NASA.* The precedent for NASA development of major national facilities exists in the various aeronautical research and wind tunnels constructed and operated by NASA and its predecessor NACA. In addition there is the example of the NASA expendable launch vehicle capability which, in recent years, has been chiefly devoted to the launch of commercial communications satellites. These national facilities have contributed directly to U.S. success in the fields of aviation and communications. *The Panel believes the policy with respect to such major facilities should remain unchanged; i.e., NASA should provide basic or unique research and operating capabilities too large or advanced for initial private sector investment.*

Using Industry Capabilities

The NASA policy of acquiring and operating its facilities, equipment, and technical services through industrial contractors has

built a competence for supporting new initiatives and exploiting space technology in the private sector. For example, several proposals to NASA involve private financing of some of the shuttle infrastructure. These are opportunities to facilitate the commercialization process and reduce NASA funding requirements without posing a threat to NASA's principal mission—research and development. *Therefore, after identifying a specific requirement for a product or service and determining that there is no compelling need to meet the requirement through a traditional NASA-controlled development program, NASA should advertise the need within the private sector as a commercial opportunity concurrently announcing that it will not initiate a competitive development.* However, difficulties encountered in the tracking and data relay satellite program in accommodating a governmental and commercial function in a single spacecraft underscore the importance of a thorough examination of the government's interest before making a private sector commitment.

Space Applications Research and Development

The NASA space applications programs are directed to the productive use of space technology and the space environment. They include but are not limited to technologies for communications, atmospheric and land remote sensing, ocean monitoring, navigation and materials processing. Research and development in the space applications field has been a major role of NASA since its inception. For example, the first transmission of global cloud cover pictures from a meteorological satellite was made from Tiros I launched on April 1, 1960. This success was followed by the Syncom II synchronous satellite communications technology demonstration in 1963. Concurrent with its continuing R&D activities to develop improved satellites and instrumentation, NASA pursued new R&D directions such as the development of the multispectral scanner to remotely monitor earth resources with the Landsat system. Demonstration of this technology was followed by R&D efforts to enhance its capabilities resulting in the development of the thematic mapper. The operational meteorological and land remote sensing systems are the responsibility of the National Oceanic and Atmospheric Administration (NOAA). (See Appendix 3.) Except

for DOD-owned systems, satellite communications operations are commercialized.

Events over the past twenty years have established a two-fold R&D role for NASA in space applications—namely, to explore new opportunities for the application of space technology and to improve demonstrated technologies to achieve the extensive operational capabilities available today. *The Panel believes these activities support critical national needs; therefore, this NASA role should be continued and expanded.* An element of this role is perhaps best illustrated by the need for advanced communications technology including the work in the 30-20 GHz frequency range. Since its demonstration in the early 1960's, the private sector has translated synchronous communications satellite technology into a highly successful growth industry. The communications satellite industry is the principal current example of commercialization of space technology, yet new technological breakthroughs are now required to maintain U.S. leadership and to realize continued economic benefits. The estimated cost of this advanced technology development exceeds the financial capability of any single firm in the industry. *The Panel recommends that NASA pursue this R&D requirement and any similar cases in space applications through demonstration of the applicable technology. In so doing, NASA should explore the feasibility of adapting the mutually beneficial experience accruing from the government/industry working relationships in conducting its aeronautical research programs, wherein NASA conducts R&D and in certain cases industry performs hardware fabrication and flight testing of new technologies under cost-sharing arrangements.*

The space shuttle manifest reveals that with minor exceptions presently scheduled commercial payloads consist of communications satellites. This fact pointedly suggests the need for NASA to identify and develop new initiatives in the application of space technology if there is to be extensive commercial utilization of the space environment. Initial research in materials processing has led to a major commercial experiment in electrophoresis under a NASA Joint Endeavor Agreement (JEA) through which NASA provides space transportation; an aerospace firm, McDonnell Douglas, provides experimental hardware and the NASA interface; and a health products company, Johnson and Johnson, furnishes experimental materials and a processing and marketing organization for products

developed. It is an endeavor that fits well into the existing technological, industrial, business and marketing strengths of the partipants. The Panel endorses this innovative JEA activity by NASA which was originated under guidelines issued by the Administrator on June 25, 1979, for the early usage of space for industrial purposes. (See Appendix 4.) Nevertheless, the fact that this experiment stands alone supports the frequently expressed view that a science base has not been established for materials processing in space. *The Panel recommends more emphasis on all aspects of NASA's materials processing program inasmuch as this appears to hold large potential for commercialization.*

Protecting Intellectual Property in Space Activities

In recognition of the substantial investment necessary to develop the electrophoresis experiment in the joint endeavor, NASA negotiated special clauses dealing with inventions and technical data. Those clauses provided that as long as the party engaged in the joint endeavor with NASA continued to pursue the experiment, that party would retain all rights to inventions and proprietary technical data. NASA would not take a government license or any "march-in" rights to require licensing of others. The only exception is if the NASA Administrator, in response to a national emergency, determines that an invention made in the performance of the joint endeavor is urgently needed for public health reasons. *The Panel recommends that NASA continue to use its flexibility to accord full rights to inventions and proprietary technical information to private parties willing to invest substantial sums in joint endeavor agreements.* (See Appendix 5.)

Strengthening the NASA-Industry Interchange

The continuing NASA programs in space research and technology and in space applications should provide a climate for the pursuit of the most imaginative ideas. However, as new developments are conceived, there is an urgent need to create an awareness of research findings among the commercial/industrial sector so as to (1) seek earlier involvement of the private sector in assessing commercial potentials and (2) plan for successful commercial exploitation of the concept early in the research and development

phase. A mechanism is also necessary to apprise the NASA research teams of the trends and requirements of the commercial entrepreneur in the space technology marketplace to identify potentially profitable areas for advanced research. *The NASA Technical Exchange Agreement with industrial firms and the Industrial Guest Investigator program are positive steps toward these objectives and their use should be expanded.* (See Appendix 4.) *The Panel also recommends that NASA, while continuing to maintain its traditional links with the aerospace industry, reinforce its efforts to establish new ties with all segments of American industry that can play an effective role in the commercialization of space.*

Modes for Risk Reduction

The July 4, 1982, space policy statement encourages domestic commercial exploitation of space capabilities. The NASA ongoing research and technology development activities represent encouragement in the form of a commitment to explore new concepts continually and to advance technology. These activities serve to reduce the business risk of high technology enterprises to a manageable level particularly when new ideas are carried through proof-of-concept and when joint experiments are conducted as a part of the NASA applications programs.

Further encouragement for the private sector is necessary, however, because of the high cost of space endeavors, particularly the cost of space transportation. Low cost access to space is essential to private sector utilization of the space environment inasmuch as an earth-based endeavor would not be burdened with such a high transportation cost element. This cost factor has been recognized by NASA in the development of its Joint Endeavor Agreement which allows free use of shuttle capability on a non-interference basis. *The JEA, or similar arrangements based on its general principles, should be extended to other proposals including the testing of experimental hardware, and other opportunities to reduce the transportation cost factor should be explored.*

While NASA may reduce technical and financial risk to the entrepreneur through R&D and space transportation, it is also important to assure stability in its commitments over the longer term if investment is to be encouraged. *The development of NASA*

commercialization policies and working agreements with the private sector should recognize the need to provide stability in NASA's business commitments over the extended periods of time usually involved in the development of space technologies.

Scientific and Technical Manpower

The successful conduct of the high technology activities inherent in the space program is wholly dependent on the availability of scientific and engineering personnel. This dependency, with respect to NASA personnel, was recognized in 1958 in drafting provisions for the Space Act. NASA, in turn, initiated programs to support university graduate level students to provide the technical skills to develop the R&D base to carry out major technological initiatives including the Apollo and other space projects. These academic programs were complemented by research grants to, and by contracts with, academic institutions which, while providing new knowledge, also contributed significantly to training additional personnel for the national scientific manpower pool.

In recent years there has been a growing awareness of (1) a shortage of students and faculty in the science, mathematics and engineering disciplines, (2) the broad technological advance in commerce and industry, and (3) the importance of a continuing source of highly trained scientists and engineers to support national economic growth. Commercialization of space technology is no exception; its success will rely to no small degree on the availability of technical skills to identify and pursue private sector initiatives. Commercialization will compete for trained manpower in a nation that is becoming more dependent on that resource for all its industrial and service activities.

NASA currently sponsors programs ranging from the post doctoral level tenable at NASA centers to the precollege-level student program for developing experiments to be carried on the shuttle. In addition, it continues its program of research grants and contracts with the university community. These activities are budgeted in excess of $225 million per year. The Panel endorses NASA activities to encourage student participation in technical endeavors and to support the education and training of additional personnel. *Recognizing the current shortage and the importance of technically*

trained personnel to commercial efforts, the Panel urges NASA to examine its university programs and to take every opportunity to strengthen its ties with the academic community with the objective of increasing the overall availability of highly skilled scientific and technical manpower for aeronautical and space technology initiatives.

IV

Organizing for Commercialization

NASA has many highly visible achievements, reflective of its responsibilities under the Space Act. Within the general business community these accomplishments project a view of NASA as a research and development, high technology, complex engineering, mission-oriented organization motivated by technical objectives and limited in the projects and goals it pursues only by government political and budgetary processes. The NASA approach to its work relies heavily on backup systems, exhaustive component qualification, repeated testing, vigorous assessment of technical risk, and extensive documentation, usually for a single item development. Within the program offices, market considerations and financial risk are not perceived as issues. Procurement generally involves sophisticated hardware and technical services and therefore, private sector interactions are predominately with the aerospace industry and its supporting infrastructure of smaller high technology companies. Aside from commercial communications satellites, the aerospace industry principally responds to a government market for space technology and hardware. On the other hand, the non-aerospace commercial/industrial community engaged in producing and marketing a variety of products has little or no familiarity with space technology and facilities and does not have the necessary special technical capability characteristic of space activities.

Against this background, it is clear that, while continuing its statutory research and development functions, NASA faces a new, distinct and challenging role in encouraging domestic commercial exploitation of space capabilities and technology. Success in this

role will depend to a large degree on real and perceived agency commitment to the objective, visibility given to it, and organization for it. The NASA program office structure does not lend itself to this goal; program offices, quite properly, are concentrating on scientific and technical objectives. *The Panel believes that a clear statement of senior management commitment and a positive program in support of commercialization as a policy compatible with the long-run future of the agency should be widely disseminated both within NASA and externally. Such action would effectively implement the President's National Space Policy. A well defined focus of responsibility at a high level within NASA should be established. Such management action will emphasize the agency's commitment to commercialization internally and externally, and it will also provide the basis for organizing and conducting the many activities involved in the process. Furthermore, leadership of the commercialization effort should be conversant with business decision-making and marketplace experience.*

To carry out this role NASA will need to examine organizational elements with a view toward consolidation of present commercialization activities to eliminate fragmentation, increase efficiency, and in the final analysis, to give credibility and support to the agency's commercialization commitment. The work to be accomplished includes:

- the development and implementation of NASA operating policies for all commercialization activities;
- the receipt, review, evaluation of and response to all private sector proposals;
- the development and negotiation of innovative agreements adaptable to varying endeavors;
- the identification of barriers to private sector involvement and the development of solutions thereto;
- the establishment of interfaces with on-going research and development activities in program offices and field centers;
- the establishment of mechanisms to expose private sector personnel to NASA research and development projects in order to identify commercial potentials and to plan for future private sector participation or exploitation as well as to obtain private sector views and trends that have implications for national economic benefit.

- maintaining liaison with other agencies, such as the Department of Commerce, engaged in fostering the growth of high technology industry to identify new commercialization techniques and to participate in joint endeavors on programs offering national economic benefit.

The Panel notes the continuing use of industry advisory committees in the conduct of the NASA aeronautics program to identify areas for research and technology advancement that offer productive benefits to the aviation industry. The Panel therefore suggests consideration be given to some adaptation of this system in the space applications and advanced technology programs, and to strengthening the commercial orientation of the existing Space Applications Board.

V

Launch Services

Expendable Launch Vehicles

NASA currently operates unmanned expendable launch vehicles and the reusable, manned space shuttle providing services to a broad spectrum of governmental and commercial customers, both domestic and foreign. The principal vehicles in the NASA ELV family, the Delta and the Atlas Centaur, have their origins in early United States rocket technology, and have been improved and uprated to a point where they reflect an outstanding reliability record. The Delta has achieved a 97% success record since 1974 with 64 successful launches out of 66 attempts. It currently has a record of 32 consecutive successful launches. The Atlas Centaur has a success record of 40 consecutive launches at this time. With the exception of the two satellites delivered with the space shuttle on November 11, 1982, the Delta and Atlas Centaur have launched all the free world commercial traffic to date.

Space Shuttle

The space shuttle has completed its fourth test flight and its second operational flight. It provides capabilities to use and explore the space environment that are not available with an ELV system. For example, in addition to carrying a larger payload to low earth orbit, the shuttle offers unique features including, but not limited to: manned and unmanned on-orbit experiment opportunities, payload deployment, servicing and retrieval, and satellite repair capabilities. Its versatility and reusablity make the shuttle the

preferred national launch system for the future with the ELVs to be phased out to eliminate the cost of maintaining two types of systems. The shuttle system has not yet demonstrated its full capabilities and its projected cost-effectiveness. However, it does not have the benefit of the fifteen years or so of operational experience enjoyed by the ELV systems, nor does it have in service the full complement of vehicles scheduled for the shuttle fleet.

Competition and Commercialization

United States government requirements excepted, market forecasts of increasing demand for commercial launch services, combined with the current limited operational status of the shuttle system, have encouraged an aggressive marketing campaign by the French Ariane ELV system. They have also resulted in proposals to NASA by commercial ventures to take over and operate the Delta and Atlas Centaur ELVs. A similar proposal has been made to the DOD for the Titan ELV system. While commercialization of the ELV systems would present competition for the space shuttle, so does the Ariane. Therefore, a commercial United States ELV can be viewed as a competitor to the Ariane, providing economic benefits and services that might otherwise be realized abroad. A competitive, rather than a protected, environment should be expected to create added incentive to drive down the cost of shuttle operations. Commercial United States ELVs would also provide a backup to the total U.S. launch capability during the initial shuttle operational period. Ultimately, however, ELV systems cannot provide the broad range of capabilities offered by the shuttle, a factor that mitigates the competitive ELV threat in the long run.

The Panel concludes that NASA should respond promptly and affirmatively to ELV commercialization proposals recognizing that the agency has already made the determination to discontinue production of the Delta and Atlas Centaur systems and that the national space policy endorses the involvement of the private sector in space commercialization. The fulfillment of any existing United States government launch commitment should be guaranteed in the commercialization arrangement.

Since the shuttle system is not yet technically mature, the Panel does not recommend consideration be given at this time to commer-

cial operation of the shuttle fleet. However, this option should be considered periodically as experience is gained in operating this complex system.

Acquisition of Expanded Shuttle Capabilities

The Panel is aware of the long standing conviction of NASA officials that a fifth orbiter is essential for full and effective use of the shuttle system to meet national needs. There is also a present requirement for a larger capacity shuttle-based upper stage to launch the heavier spacecraft emerging from advanced commercial spacecraft programs. Such a stage is essential for future shuttle effectiveness and competitiveness. Proposals for private sector financing and marketing of both of these vehicles have been presented to NASA. The Panel makes no judgment on the feasibility or worthiness of these proposals; however, both proposals represent possible steps in the development of a commercial infrastructure for space operations. *Since NASA should concentrate on research and development and is limited to activities beneficial to the general public, full commercial utilization of the space environment implies the need for a privately owned transportation system. Therefore, NASA should assess these proposals with longer range contributions in mind.*

Launch Services Stability

Space activities are characterized by large investments, high technical and financial risk and by long development periods. These factors place a premium on sound business planning that becomes difficult without the knowledge and stability of launch costs, certainty of launch availability and consistency of government policy over a period of time. *The Panel appreciates that some policies may be beyond NASA's control. However, the agency commercialization policy should recognize the importance to business endeavors of stable launch costs and the availability of space transportation and should strive to minimize any uncertainties.*

VI

Financial Considerations Affecting Investment

Preceding sections of this report have discussed various ways by which NASA can help to encourage business ventures in space technologies by developing a climate attractive to potential investors. This section takes up three sets of related issues influencing investment in such ventures.

The government has been the developer of space technology and the provider of facilities for space activities. These may be essential to commercial enterprises in space. The Panel believes commercialization will be encouraged if existing government assets which are no longer necessary for government programs can be made available by transfer, sale or lease to an interested private entrepreneur. The first item below discusses realistic valuation of these government interests.

The new types of risk involved in commercial ventures in space call for insurance coverages adapted to those risks. The second item assesses the adequacy of the several types of insurance coverage.

The third part of this section presents a short discussion of Federal tax law provisions favoring various types of corporate activities including business ventures in space technologies.

Realistic Valuation of Government Interest

Over the past 25 years, the $100 billion expended in the civilian space program has moved the nation from zero base to a leadership position in space technology. This expenditure has produced remarkable scientific and engineering achievements. It has widely

extended the national research and technology base and has built an infrastructure that can support more and more advanced activities in the space environment.

Under an annual authorization procedure, the Congress has subjected NASA's proposed programs, projects, and research tasks, and their objectives, to intensive review and analysis. Upon approval, the appropriations process then incorporated a further review of NASA's activities, providing a full understanding of the costs required to carry out the approved tasks and meet their objectives. The NASA record of effective management and successful performance is long and exemplary. The achievements include manned and unmanned exploration of the moon, unmanned laboratories on Mars, Venus probes, spacecraft flybys of Jupiter and Saturn, the development and demonstration of communications, meteorological and earth resources satellite technology, and the development of launch systems and other infrastructure to support these and other approved objectives.

The nation has received and continues to realize the benefits that were set forth as justification for the Congressional appropriations. Moreover, greater value has often been received than had been anticipated or hoped for initially. For example, while a 15-unit Saturn V/Apollo vehicle program was originally approved, the national lunar landing goal was achieved in 1969 with the sixth Saturn V launch vehicle. This success provided the opportunity for an additional five lunar exploration missions and the launch of the Skylab space station. The Skylab program demonstrated that man can live and perform useful work in space for extended periods of time.

New programs requiring new technologies have been approved and undertaken as objectives have been attained. Most recently, for example, the space shuttle completed its first operational flight. Older, completed programs have been phased out or shut down. Thus, such facilities as the Saturn 1B launch complexes 34 and 37 have been dismantled, having fulfilled their programmatic purpose and becoming obsolete.

Accounting statements in the Federal budget and in most Federal agencies do not include a balance sheet. Agencies generally do not record depreciation (or capital consumption) allowances or writeoffs for obsolete and no longer used equipment. Thus, since

they are the only data available, many observers believe that acquisition costs represent a fair measure of the value of the assets managed or held by a Federal agency. This is an erroneous conception, particularly (but not exclusively) for those obsolete facilities or equipment that currently are worth no more than scrap or salvage value, as would be the case of some of the materials in the hands of NASA. *Thus, the Panel concludes that once program objectives have been achieved or a facility has served its intended purpose, the nation has received full value for its expenditure. At that point, the Panel believes the Federal Government's estimate of the currently remaining value of its assets should be determined by their worth in the marketplace, not by what the historical costs may have been to produce them.*

For example, the Delta and Atlas Centaur expendable launch systems are being phased out by NASA. Proposals to commercialize these systems could involve a transfer, sale, or lease of existing government assets to a private sector entrepreneur, in which the fair value of the assets could become an issue.

Admittedly, the market for determining an appropriate price for such assets is likely to be "thin," or limited. Despite the difficulties in establishing "fair market value," it is important for the nation to recognize the net benefits that can accrue to the public from such a transfer, sale, or lease of assets. In addition to the specific products and services that might be provided by innovative commercial ventures in space, there would be other benefits such as employment opportunities, increased tax revenues at the state, local, and Federal level, and backup national launch capability to meet currently unforeseen or future emergency needs of NASA or the DOD. This is especially true if the alternative implies that the assets would remain idle.

The Panel recognizes that the Federal Property and Administrative Services (FPAS) Act provides for the disposal of excess and surplus government property, and is concerned that the present law, and regulations issued pursuant thereto, might not provide sufficiently high purchase priority to commercial space ventures, ventures that were not foreseen at the time of enactment. *The Panel therefore suggests that consideration be given to either amending the FPAS Act, the regulations, or both, or to obtaining other legislative authority, if such action is needed to provide the author-*

ity required to realize continuing public benefits. In any event the Panel strongly believes that the view expressed earlier in this subsection on the value of NASA's no-longer-needed assets should be applied to help encourage and facilitate commercial ventures in space. Aside from the above considerations, the Panel makes no judgment on any proposal other than those views expressed in Sections V and X of this report.

Insurance

Beginning with development and launch of the first commercial synchronous satellite, Early Bird I, the insurance industry, as an outgrowth of its aviation insurance activities, has provided the insurance coverages to support the growing communications satellite industry. First party property coverages, frequently referred to as hull insurance, have been available during handling and prelaunch activities as well as during the launch phase.

NASA, with its Delta and Atlas Centaur ELVs, and the space shuttle, has been the launch agent for the commercial communications satellite industry, and in that role it has also administered U.S. government treaty commitments with respect to third party liability. Consequently, NASA has played an active role in insurance and indemnification matters to facilitate the commercialization process. NASA launch service agreements require users to obtain third party liability insurance in amounts agreed to by NASA and the user "in view of the insurance available in the world market at a reasonable premium," not to exceed $500 million of coverage for each launch service. As a practical matter, $500 million has been established as the liability coverage to be obtained by each user.

As the time for conducting commercial activities with the shuttle approached, NASA initiated several actions to assist with the transition to and the utilization of shuttle capabilities. First, in 1979 NASA requested, and the Congress approved, an insurance and indemnity amendment to the Space Act, set forth in Section 308(a), authorizing NASA to provide liability insurance, and charge the user a fee therefor, or indemnify the user in cases when it is impractical or when a user is unable to obtain adequate insurance. This authority was designed to encourage the use of the space environment by easing the insurance burden for space shuttle ac-

tivities such as "get-away specials" which involve small experimental packages sponsored by a variety of users. The Section 308 authority also authorizes NASA to indemnify a user in excess of the third party liability coverage obtained, i.e., above $500 million. In addition NASA, with respect to the shuttle, enters into cross-waiver agreements with users providing that each assumes responsibility for its own property without recourse against the other in event of a loss. Thus, a spacecraft owner is indemnified against any shuttle damage caused by the spacecraft and NASA is indemnified against damage to the spacecraft.

Space technology changes rapidly and circumstances change accordingly, introducing new challenges in the insurance process. For example, the shuttle provides new and different capabilities, and communications spacecraft are getting larger, more complex and more expensive. To date, United States expendable launch vehicles have had the capacity for only one communications spacecraft; the shuttle can carry as many as four Delta-class spacecraft. The insurance industry provided the coverage required for the two-spacecraft STS-5 launch. However, there is a present concern that difficulties may be encountered in obtaining coverages for a three or four spacecraft shuttle launch. NASA is now examining this issue with the insurance industry.

Essentially all space insurance requirements have hitherto involved communications spacecraft. Commercialization of other space technologies most likely will introduce different first and third party insurance problems. These must be addressed if the private sector is to invest in space enterprises. Capital will not be put at risk without the availability of insurance to cover hardware losses or to provide indemnification against third party claims. NASA has done a creditable job in initiating actions and in working with the insurance industry to foster an insurance system for space activities. *NASA should not enter into the insurance business. Nevertheless, since NASA is the generator of much of the new space technology and therefore most familiar with the complexities and the implications of it, the Panel believes NASA must continue to inform itself on insurance needs and problems, and to work closely with the insurance industry to seek solutions to insurance barriers to commercialization of space technology.*

Federal Income Tax Considerations

Since the inception of Federal income taxation, it has generally been believed that innovative efforts in society could be induced by the enactment of tax incentives; but it appears that there is little direct quantitative evidence regarding the impact of tax incentives on the rate and timing of R&D and innovation. (See National Science Foundation study, *Tax Policy and Investment in Innovation,* 1982.) It is not the issue whether governmental intervention in support of a market economy is desirable or whether tax incentives even have a favorable effect on innovative activity. The fact is the Federal tax law contains a number of provisions that favor certain types of organizations to encourage activities such as business ventures in space technologies. A brief review of these statutory provisions follows:

- *R&D Expenditures* (See Treasury Regs. #1.174-2 (a) (1).) May be deducted currently or capitalized and then amortized over a 60-month period beginning when income is generated from the R&D expenditures.
- *Special Treatment on Sale of Technology* Is afforded the individual professional inventor (as opposed, for example, to an author) whose income from the sale of his patent will be taxed at capital gains rates rather than those of ordinary income.
- *Venture Capital Investments in New Technology-Based Firms* Can be formed so as to avoid income tax at the corporate level if they are principally engaged in the development or exploitation of inventions, technological improvements, new processes or products not previously available.
- *Small Business Investment Companies (SBICs)* While not exclusively limited to technological firms, such investment vehicles offer substantial tax incentives to investors, and the SBICs have been a substantial underwriter of technology-based ventures.

The Panel believes that in light of the existing special provisions in the Tax Code relating to incentives for technological innovation, no special tax legislation need be enacted to encourage business ventures in space technologies, still a rapidly growing new frontier. The Panel recognizes that the Congress' interest in the broader issue of incentives for innovation will work to the benefit

of business ventures in space. Later developments should be carefully audited to determine whether or not the uniqueness of a commercial role in space ventures will suggest a modification of this viewpoint. At this stage it seems unwise to change present options available under our tax system.

VII

Anticompetitive Considerations

Space commercialization ventures do not raise antitrust issues simply because they involve the space environment. Moreover, the fact that these ventures are in an experimental stage and that the experiments are being carried out through joint endeavors with NASA, a government agency, makes it unlikely that antitrust problems will arise. However, as successful development of products and processes in space ventures move into the private sector, consideration should be given to several aspects having antitrust implications, including the need to use the essential space transportation facilities presently owned and controlled by NASA and the capital intensive nature of space ventures. These factors may be instrumental in the creation of market power by a single firm or, what is more likely, necessitate the formation of joint ventures in research and development by large firms that might otherwise be in competition.

The model now being used is the Joint Endeavor Agreement developed by NASA. Such an agreement has been made between NASA and McDonnell Douglas (working with Johnson & Johnson) to conduct research for the manufacture of certain pharmaceuticals during four trips on the space shuttle over a seven year period. NASA entered into this agreement after soliciting offers through a notice in the Federal Register. It agrees to furnish the four trips on the space shuttle without charge. However, it will not offer the same conditions to firms engaged in similar research. McDonnell Douglas pays for the cost of conducting the research and retains exclusive rights to the patents and know-how, except where NASA

determines that the subject matter is not being supplied "in sufficient quantity and at reasonable prices to satisfy market needs."

The use of an essential facility, such as the space shuttle, "should be open to all on a nondiscriminatory basis" according to the Department of Justice antitrust division. The Federal Register solicitation by NASA probably meets this requirement. If, in the future, some launch facilities are to be operated by private firms, this "essential facility domain" may be a factor to consider from an antitrust standpoint. The concern may be alleviated if these operations are under the supervision of a regulatory agency, either by express or implied exemption from the antitrust laws. Proposed legislation to this effect is presently before Congress.

Like other industrial activities, space commercialization ventures are engaged in a search for technologically innovative products and processes which can be profitably marketed. This search area has been the subject of widespread concern and discussion in recent years because of the perception that United States leadership in this area is being eroded by aggressive initiatives in Japan and Western Europe. It is argued that United States antitrust laws are significantly responsible for this state of affairs. The Department of Justice antitrust division issued its Antitrust Guide Concerning Research Joint Ventures in November 1980. This guide seeks to clarify what can and cannot be done. It also refers to its Business Review Procedure whereby joint ventures may obtain an opinion from the Department regarding planned activities. However, many deem this inadequate because the Department makes no enforceable commitment.

As a result, a number of legislative proposals are before Congress which seek to provide certainty for joint research and development ventures. These are of two types. One provides for a Certificate of Review Procedure by the Attorney General, modelled on the Export Trading Company Act of 1982, which protects those getting favorable reviews from criminal and civil antitrust liability. The other sets forth statutory guidelines for obtaining immunity from criminal and civil antitrust liability. Thus, in the first, there is up front clearance by the Attorney General, and in the latter, the venture may be challenged in the courts after it gets under way.

These legislative proposals are a modest step toward removing the uncertainties of the antitrust laws for research and development

ventures, including space commercialization projects. The Department of Justice objects to the certificate of review procedure because of its alleged regulatory nature. It urges, instead, that Congress focus on modifying private treble damage action which is said to be the main source of antitrust litigation. However, the certificate of review procedure seems to be a small departure from the existing business review procedure. It has widespread support and may, at least, help in encouraging industry to proceed with innovative technological projects.

The Panel recognizes that space commercialization projects, in their present experimental stage and in the manner by which NASA is conducting its joint endeavor arrangements with private firms, are not likely to raise antitrust issues. However, since it anticipates that marketable products and processes will be developed and that more controls may move into the private sector, the debate over present uncertainties in the antitrust laws should be monitored.

It supports the legislative objectives, represented by the bills now before Congress, to obtain more certainty in the antitrust laws for joint ventures in research and development. The Panel also recognizes that these specialized measures are only steps in the development of a more coherent body of antitrust law principles than presently exists not only with regard to joint ventures in research and development but also with other aspects which may encourage the growth of economic activity in an international competitive environment.

VIII

Organizing for the Regulatory Process

Except for the Conestoga I launch by Space Services, Inc. on September 9, 1982, United States space operations have been government ventures or subject to a virtually automatic governmental control process because all launch systems and launch sites were government-owned. Commercial activities in space have been limited to communications satellites which fell within the existing regulatory framework of the Federal Communications Commission (FCC). Under these circumstances effective mechanisms existed for assuring the public safety and for complying with the international obligations of the United States set forth in several treaties. (See Appendix 6.) The Outer Space Treaty and the Convention on International Liability for Damage Caused by Space Objects establish two major obligations – first, liability for damage caused by a space object originating from the United States as the launching state which is provided for through the terms of NASA's launch service agreements, and second, the responsibility of the United States to authorize and continually supervise these non-government payload activities in outer space [which is satisfied by the FCC's approval] requirements for communications satellites.

The United States has also agreed to register with the United Nations all space objects launched from United States territory in accordance with the 1976 Convention on Registration of Objects Launched Into Outer Space. With government controlled launches, this registration requirement has become routine. The more recent Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques was ratified in 1980. It

is not considered applicable to commercial communications satellites. The principal public policy concern in the production and sale of a commercial communications satellite to an international organization or a foreign country is compliance with the United States International Traffic in Arms Regulations administered through a Department of State licensing procedure to control the export of sensitive technologies.

Growth and diversification in the commercialization of space technology can be expected to require a different approach to the authorization and supervision process. For example, an Ariane launch of a United States-built domestic communications satellite requires FCC approval and an export license (to a foreign launch site); it also requires the United States to address its obligations under the liability convention, under this new circumstance. Future regulatory needs might be better illustrated by the Conestoga I launch by Space Services, Inc., a private sector venture involving the test of a new launch vehicle from a new launch site. Theoretically, it could have been launching a commercial payload designed for any number of purposes. Multiple agency clearances were required for that launch including:

- an export license issued by the State Department to satisfy munitions export control requirements;
- a Federal Aviation Administration authorization to utilize air space above and around the launch site;
- an FCC radio frequency allocation for launch monitoring;
- a destructive device (rocket) registration with the Alcohol, Tobacco, and Firearms unit of the Treasury Department;
- an Internal Revenue Service filing;
- a launch notification to the North American Air Defense Command.

In the process of granting these clearances, the government had to assure that United States treaty obligations were satisfied. This is clearly a laborious and, in this particular case, an expensive process. In addition to those considerations introduced by a potential commercial expendable launch vehicle operation, the anticipation of new types of commercial payloads, other than communications spacecraft, further underscores the need for an inspection, control and approval system. The government must assure that its national

security, foreign policy, public safety and treaty obligations are met.

Although a user-conducted multiple agency clearance process has been adequate to this point, it is expected that a more formal and centralized government clearance arrangement will ultimately become necessary to facilitate space commercialization activities. Legislation introduced in the Conrgess and interagency reviews are expected to explore this issue to determine the most appropriate methods of addressing the matter. *The Panel believes, however, that NASA should not be placed in a regulatory or central clearance role with respect to space commercialization initiatives. Other agencies are better suited for this task and it is important that NASA avoid a conflict of interest, either imagined or real, with its R&D responsibilities. Nevertheless, NASA should encourage and support simplification of the clearance system. Further, because of its expertise in space technology, NASA should be prepared to provide technical advice and support to any other agency participating in or having a regulatory role in space commercialization activity. It should also assist commercial organizations seeking clearances to exploit a NASA technology.*

IX

Addressing National Security Concerns

Since its inception NASA has had as one of its major responsibilities the support of U.S. military objectives in space. Conversely, national defense agencies are obligated under the Space Act to provide to NASA information from military space activity which may be of value to the civilian program. The first of the several goals enunciated in the National Space Policy is to "strengthen the security of the United States." That statement, in dealing with the Space Transportation System, also indicates that "Launch priority will be provided for national security missions."

Commercialization activities are encouraged under the present policy but must be "consistent with national security concerns." Because the interest in commercialization is relatively new, there is little experience to guide private firms undertaking new initiatives in space. It seems evident, therefore, that one of the Federal Government's first responsibilities in encouraging private investment is to clarify the basis for determining what constitutes a "national security concern."

Shuttle customers, for example, will obviously want to know the odds for being preempted by a military payload priority. At the present time the risks of such preemption are said to be slight, and commercial users are advised that preemption will be exercised only when absolutely necessary and after full consideration of the potential adverse effect on a commercial venture.

The determination of whether a potential commercial enterprise involves national security concerns or conflicts that would preclude private sector development is an interagency matter. It falls under

the purview of the Senior Interagency Group on Space (SIG) chaired by the Assistant to the President for National Security Affairs. *NASA, as a member of SIG, should assume a lead role in representing the case for commercialization of space technologies and pursue the identification and publicizing of the criteria by SIG for determining the acceptability of proposed ventures.*

X

Guidelines for NASA Evaluation of Commercialization Proposals

NASA has received proposals for the commercialization of space technology covering a wide variety of activities. Because of the variety of applications and the differing technologies involved, it is essential for NASA to have flexibility in the evaluation process and in the mechanisms adopted for NASA support to or participation in an endeavor. On the other hand, there is a need for uniform guidance and a common understanding of the evaluation process to assure fair and equal treatment and to help NASA make rational, consistent and expeditious judgments on proposals. Accordingly, the Panel suggests some general principles to guide the NASA evaluation process. These principles are followed by two sets of guidelines addressing the mechanisms of the evaluation process. These are designated as policy considerations and specific requirements. (Nothing in this section should be interpreted as a modification of or substitution for United States commitments to foreign governments or international organizations with respect to international cooperation in the development and application of space science and technology.)

General Principles

- Equal opportunity should be assured for all United States firms and citizens to participate in the development, utilization, and exploitation of space technology.
- Each proposal should be subjected to a uniform review procedure with defined processing phases.

- Each proposal must put capital or other private resources at risk.
- Commercial criteria, not NASA or the government as a whole, should determine the success or failure of a proposal.
- NASA should be completely candid, and should provide a prompt and authoritative response to a proposal in order that business decisions can be made expeditiously on the basis of reliable information.
- NASA, except where a clear and identifiable public interest demands it, should not compete with the private sector. It should commit to this principle on a specific undertaking for specific periods of time in order to foster a climate of stability and continuity for business decisions. The nature and extent of any such exceptions should be specifically defined.
- Since unique and expensive government-owned facilities often play a vital role in space activity, NASA should develop and maintain a well-defined policy with respect to the availability, use and cost of such facilities for commercial endeavors.
- NASA should take an active role in resolving problems affecting commercialization proposals with multi-agency implications.

Policy Considerations

These considerations are designed to facilitate a timely decision that a proposal should be processed or rejected. If a proposal does not pass this initial screening, the proposer should be so advised and no time or effort should be devoted to a formal evaluation of the proposal. For example, if there is a national security bar to a proposed commercial activity, it should be so stated and further processing terminanted.

The extent to which a proposed endeavor would affect a present or future governmental activity, or foreign policy interest:

- Is it realistic to commercialize or to support the commercialization of an activity which, due to a priority interest in the government, would preclude the creation and exploitation of a market through the use of risk capital?
- Is it possible to separate out the critical governmental interest for retention by the Government while releasing the remain-

ing portions of the activity for commercialization? Such a determination should assure that the government and the private sector are not placed in competition.
- If immediate commercialization is not practical because of an overriding government interest, is future commercialization possible when technology advances or national security concerns change?

The extent to which a proposal serves the public interest by meeting one or more of the following criteria:
- Does the proposal promise to enhance the national research and technology base through scientific experimentation or through the performance of R&D to advance the state of space technology and apply it to the commerical marketplace?
- Is the proposal designed to use space technology to create products or services that, given success, would produce employment opportunities, tax revenues and other economic benefits over a period of time?
- Does the proposal offer contributions to the general health of the population through technology advances?
- Will proposals for using space technology and/or the space environment provide benefits to the general public in education, culture, recreation and/or entertainment?
- Is the proposal designed so as to prevent clutter or debris in the space environment to the detriment of other activities?

Specific Requirements

This category is intended to provide guidance in determining the adequacy of a specific proposal to achieve a desired result and to form a basis for negotiating NASA participation in or support for the proposed activity. The assessment of these factors will be a key determinant of the nature and degree of assistance or incentive NASA might offer and for deciding when NASA should disengage from a joint endeavor.
- The proposed activity should be technically feasible, i.e., should not be inconsistent with any fundamental principles of science and engineering.
- The management and technical capability of the proposer and

the work program should be sufficiently delineated to judge its adequacy for carrying out the work involved.

- The proposal should clearly establish the financial responsibility of the proposer and the availability of other resources to carry the proposal to completion.
- The facility requirements should be identified and a plan for satisfying such requirements should be provided.
- In those proposals requesting government support, the tangible or intangible offsetting benefits to the nation should be clearly stated and credible.
- The proposal should specify to what extent and how the government would be indemnified against losses due to the proposer's negligence or failure to perform.
- Solutions should be proposed to any problems presented to NASA in honoring requests for the protection of proprietary information and processes.
- The proposal should provide for an appropriate allocation of rights in inventions and proprietary information.
- Any foreign policy and national security implications should be identified, and realistic approaches should be proposed to assure that a commercial activity is, and will remain, consistent with such requirements.

Panel on Encouraging Business Ventures in Space Technologies

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Office of the White House Press Secretary

The White House
Fact Sheet
National Space Policy

The President announced today a national space policy that will set the direction of US efforts in space for the next decade. The policy is the result of an interagency review requested by the President in August 1981. The ten-month review included a comprehensive analysis of all segments of the national space program. The primary objective of the review was to provide a workable policy framework for an aggressive, farsighted space program that is consistent with the Administration's national goals.

As a result, the President's Directive reaffirms the national commitment to the exploration and use of space in support of our national well-being, and establishes the basic goals of United States space policy which are to:

- strengthen the security of the United States;
- maintain United States space leadership;
- obtain economic and scientific benefits through the exploitation of space;
- expand United States private sector investment and involvement in civil space and space related activities;
- promote international cooperative activities in the national interest; and
- cooperate with other nations in maintaining the freedom of space for activities which enhance the security and welfare of mankind.

The principles underlying the conduct of the United States space program, as outlined in the Directive are:

- The United States is committed to the exploration and use of space by all nations for peaceful purposes and for the benefit of mankind. "Peaceful purposes" allow activities in pursuit of national security goals.

• The United States rejects any claims to sovereignty by any nation over space or over celestial bodies, or any portion thereof, and rejects any limitations on the fundamental right to acquire data from space.

• The United States considers the space systems of any nation to be a national property with the right of passage through and operation in space without interference. Purposeful interference with space systems shall be viewed as an infringement upon sovereign rights.

• The United States encourages domestic commercial exploitation of space capabilities, technology, and systems for national economic benefit. These activities must be consistent with national security concerns, treaties and international agreements.

• The United States will conduct international cooperative space-related activities that achieve scientific, political, economic, or national security benefits for the nation.

• The United States space program will be comprised of two separate, distinct and strongly interacting programs—national security and civil. Close coordination, cooperation and information exchange will be maintained among these programs to avoid unnecessary duplication.

• The United States Space Transportation System (STS) is the primary space launch system for both national security and civil government missions. STS capabilities and capacities shall be developed to meet appropriate national needs and shall be available to authorized users—domestic and foreign, commercial and governmental.

• The United States will pursue activities in space in support of its right of self-defense.

• The United States will continue to study space arms control options. The United States will consider verifiable and equitable arms control measures that would ban or otherwise limit testing and deployment of specific weapons systems, should those measures be compatible with United States national security.

Space Transportation System

The Directive states that the Space Shuttle is to be a major factor in the future evolution of United States space programs, and that it will foster further cooperative roles between the national se-

curity and civil programs to insure efficient and effective use of national resources. The Space Transportation System (STS) is composed of the Space Shuttle, associated upper stages, and related facilities. The Directive establishes the following policies governing the development and operation of the Space Transportation System:

- The STS is a vital element of the United States space program, and it is the primary space launch system for both United States national security and civil government missions. The STS will be afforded the degree of survivability and security protection required for a critical national space resource. The first priority of the STS program is to make the system fully operational and cost-effective in providing routine access to space.
- The United States is fully committed to maintaining world leadership in space transportation with a STS capacity sufficient to meet appropriate national needs. The STS program requires sustained commitments by each affected department or agency. The United States will continue to develop the STS through the National Aeronautics and Space Administration (NASA) in cooperation with the Department of Defense (DoD). Enhancement of STS operational capability, upper stages and methods of deploying and retrieving payloads should be pursued, as national requirements are defined.
- United States Government spacecraft should be designed to take advantage of the unique capabilities of the STS. The completion of transition to the Shuttle should occur as expeditiously as practical.
- NASA will assure the Shuttle's utility to the civil users. In coordination with NASA, the DoD will assure the Shuttle's utility to national defense and integrate national security missions into the Shuttle system. Launch priority will be provided for national security missions.
- Expendable launch vehicle operations shall be continued by the United States Government until the capabilities of the STS are sufficient to meet its needs and obligations. Unique national security considerations may dictate developing special purpose launch capabilities.
- For the near term, the STS will continue to be managed and operated in an institutional arrangement consistent with the cur-

rent NASA/DoD Memoranda of Understanding. Responsibility will remain in NASA for operational control of the STS for civil missions and in the DoD for operational control of the STS for national security missions. Mission management is the responsibility of the mission agency. As the STS operations mature, the flexibility to transition to a different institutional structure will be maintained.

• Major changes to STS program capabilities will require Presidential approval.

The Civil Space Program

In accordance with the provisions of the National Aeronautics and Space Act, the Directive states that the civil space program shall be conducted:

- To expand knowledge of the Earth, its environment, the solar system and the universe;
- to develop and promote selected civil applications of space technology;
- to preserve the United States leadership in critical aspects of space science, applications and technology; and
- to further United States domestic and foreign policy objectives.

The Directive states the following policies which shall govern the conduct of the civil space program:

• United States Government programs shall continue a balanced strategy of research, development, operations, and exploration for science, applications and technology. The key objectives of these programs are to: (1) preserve the United States preeminence in critical space activities to enable continued exploitation and exploration of space; (2) conduct research and experimentation to expand understanding of: (a) astrophysical phenomena and the origin and evolution of the universe through long-lived astrophysical observation; (b) the Earth, its environment, its dynamic relation with the Sun; (c) the origin and evolution of the solar system through solar, planetary, and lunar sciences and exploration; and (d) the space environment and technology to advance knowledge in the biological sciences; (3) continue to explore the requirements, operational concepts, and technology associated with permanent space facili-

ties; (4) conduct appropriate research and experimentation in advanced technology and systems to provide a basis for future civil applications.

• The United States Government will provide a climate conducive to expanded private sector investment and involvement in space activities, with due regard to public safety and national security. These space activities will be authorized and supervised or regulated by the government to the extent required by treaty and national security.

• The United States will continue cooperation with other nations in international space activities by conducting joint scientific and research programs, consistent with technology transfer policy, that yield sufficient benefits to the United States, and will support the public, nondiscriminatory direct readout of data from Federal civil systems to foreign ground stations and the provision of data to foreign users under specified conditions.

• The Department of Commerce, as manager of Federal operational space remote sensing systems, will: (1) aggregate Federal needs for these systems to be met by either the private sector or the Federal government; (2) identify needed research and development objectives for these systems; and (3) in coordination with other departments or agencies, provide regulation of private sector operation of these systems.

The National Security Space Program

The Directive states that the United States will conduct those activities in space that it deems necessary to its national security. National security space programs shall support such functions as command and control, communications, navigation, environmental monitoring, warning, surveillance and space defense. The Directive states the following policies which shall govern the conduct of the national security program:

• Survivability and endurance of space systems, including all systems elements, will be pursued commensurate with the planned use in crisis and conflict, with the threat, and with the availability of other assets to perform the mission. Deficiencies will be identified and eliminated, and an aggressive, long-term program will be undertaken to provide more-assured survivability and endurance.

• The United States will proceed with development of an anti-satellite (ASAT) capability, with operational deployment as a goal. The primary purposes of a United States ASAT capability are to deter threats to space systems of the United States and its Allies and, within such limits imposed by international law, to deny any adversary the use of space-based systems that provide support to hostile military forces.

• The United States will develop and maintain an integrated attack warning, notification, verification, and contingency reaction capability which can effectively detect and react to threats to United States space systems.

• Security, including dissemination of data, shall be conducted in accordance with Executive Orders and applicable directives for protection of national security information and commensurate with both the missions performed and the security measures necessary to protect related space activities.

Inter-Program Responsibilities

The Directive contains the following guidance applicable to and binding upon the United States national security and civil space programs:

• The national security and civil space programs will be closely coordinated and will emphasize technology sharing within necessary security constraints. Technology transfer issues will be resolved within the framework of directives, executive orders, and laws.

• Civil Earth-imaging from space will be permitted under controls when the requirements are justified and assessed in relation to civil benefits, national security, and foreign policy. These controls will be periodically reviewed to determine if the constraints should be revised.

• The United States Government will maintain and coordinate separate national security and civil operational space systems when differing needs of the programs dictate.

Policy Implementation

The Directive states that normal interagency coordinating mechanisms will be employed to the maximum extent possible to implement the policies enunciated. A Senior Interagency Group (SIG) on Space is established by the Directive to provide a forum

to all Federal agencies for their policy views, to review and advise on proposed changes to national space policy, and to provide for orderly and rapid referral of space policy issues to the President for decisions as necessary. The SIG (Space) will be chaired by the Assistant to the President for National Security Affairs and will include the Deputy Secretary of Defense, Deputy Secretary of State, Deputy Secretary of Commerce, Director of Central Intelligence, Chairman of the Joint Chiefs of Staff, Director of the Arms Control and Disarmament Agency, and the Administrator of the National Aeronautics and Space Administration. Representatives of the Office of Management and Budget and the Office of Science and Technology Policy will be included as observers. Other agencies or departments will participate based on the subjects to be addressed.

Background

In August 1981, the President directed a National Security Council review of space policy. The direction indicated that the President's Science Advisor, Dr. George Keyworth, in coordination with other affected agencies, should examine whether new directions in national space policy were warranted. An interagency working group was formed to conduct the study effort and Dr. Victor H. Reis, an Assistant Director of the Office of Science and Technology Policy, was designated as Chairman. The group addressed the following fundamental issues: (1) launch vehicle needs; (2) adequacy of existing space policy to ensure continued satisfaction of United States civil and national security program needs; (3) Shuttle organizational responsibilities and capabilities; and, (4) potential legislation for space policy. The reports on the various issues formed the basis of the policy decisions outlined here. The following agencies and departments participated: State, Defense, Commerce, Director of Central Intelligence, Joint Chiefs of Staff, Arms Control and Disarmament Agency and the National Aeronautics and Space Administration, as well as the National Security Council Staff and the Office of Management and Budget.

Meteorological and Land Remote Sensing (Landsat) Satellite Systems

This appendix presents background and current status of the meteorological and land remote sensing satellite systems developed by NASA and subsequently transferred for operation to the National Oceanic and Atmospheric Administration (NOAA), Department of Commerce (DOC). NASA continues advanced instrumentation R&D to increase the capability of these space systems. The Panel examined the history of these applications of space technology to identify any characteristics of significance to its study. Operation of these satellite systems remains a governmental function in NOAA; however, several studies have recently been completed with respect to future operational modes, and NOAA announced a Presidential decision on March 8, 1983, to offer both systems for sale to the private sector. The Panel considers the status of these operational systems to be outside the scope of its study for NASA.

Meteorological Satellite Systems

Meteorological and communications satellite systems were early and successful NASA initiatives in the application of space technology. Tiros I was launched April 1, 1960, and Syncom II, July 26, 1963. Responsibility for the operational use of communications satellite technology was transferred to the private sector by the Communications Satellite Act of 1962, placing it in the traditional arena for the communications function in the United States.

Meteorological satellites were integrated with the existing weather service, a governmental function since 1870, to provide a new and unique capability for weather forecasting and research. The program is operated under a long standing NASA/DOC/NOAA interagency agreement, originated in 1962, covering both the Tiros/NOAA series of polar orbiting satellites and the series of geostationary orbit satellites. NASA performs R&D on advanced spacecraft and sensors, transfers new systems to NOAA after com-

pleting engineering evaluation, and procures and launches all operational spacecraft for NOAA on a reimbursable basis. NOAA finances and operates the operational system through its National Environmental Satellite, Data, and Information Service.

In recent months, at least one proposal was presented to take over and operate the existing civil meteorological satellite systems as a commercial venture. Studies of private sector operation were conducted in the Executive Branch. Private sector operation introduces several issues including popular expectations of services resulting from a historical governmental function, international commitments to furnish satellite data, and the ability to meet United States government meteorological requirements. Whether such operation, relying heavily on government purchase of data, represents commercialization of space technology or is in effect a contracting out of government functions is open to debate. In contrast to the ELV circumstances where the government is phasing out because its ELV requirements will eventually terminate, the meteorological satellites represent a continuing operational need for a service traditionally rendered by the government.

As noted above, a decision has recently been made to offer these systems for sale either as a package with the Landsat system or separately.

Land Remote Sensing (Landsat) Satellite System

The land remote sensing system, Landsat, is a development initiated by NASA to acquire data to assist in the management of the Earth's resources. Landsat 1, the first spacecraft, was launched in 1972. Its two instruments, a multispectral scanner (MSS) and a return beam vidicon camera, provided experimental data on a variety of subjects including geologic features, land use, agricultural crops, hydrology and water pollution. Landsat 2, identical to Landsat 1, and Landsat 3, with some added capability in both instruments, were subsequently launched to provide data continuity to an increasing number of ground stations including eleven in eleven foreign countries. The system is operated on an "open skies" policy and data are provided to foreign ground stations in accordance with a NASA cooperative agreement for a $600,000 annual fee. Until recently, this fee was a nominal $200,000. NASA continued R&D on advanced space and ground systems designed

to improve data acquisition capability and to enhance ground processing of the data. Landsat 4, with a new instrument, the thematic mapper, and a multispectral scanner was launched in 1982. A second Landsat 4 spacecraft is nearing completion and will be placed in storage.

Even though it was an experimental system, soon after the Landsat capability was demonstrated several issues arose including continuity of data, establishment of an operational system, market aggregation (diversity of users, type of desired coverage, and location), system subsidy, and transfer of the remote sensing function to the private sector. Many studies were conducted, bills were introduced in the Congress and several hearings were held, and at least one private sector firm proposed to take over the operation. An Office of Science and Technology Policy review completed in 1979 resulted in a Presidential directive designating NOAA as the single agency to manage the operational land remote sensing system. The directive also required NOAA to seek ways to achieve eventual operation by the private sector. Effective February 1, 1983 NASA transferred the operation and management of the Landsat system to the NOAA National Environmental Satellite, Data and Information Service. This transfer included all spacecraft and ground facilities except for the thematic mapper instrument on Landsat 4 which is still undergoing engineering evaluation by NASA. NASA will continue to perform R&D on new instruments. The present NASA/NOAA arrangement closely parallels the one established for the meteorological satellites.

The need for funds in the Federal budget to procure follow-on spacecraft to provide data continuity after the two Landsat 4s caused further examinations of mechanisms to transfer civil land remote sensing systems to the private sector. The issue was placed before the Cabinet Council on Commerce and Trade, chaired by the Secretary of Commerce. The Secretary of Commerce also formed an advisory committee of non-federal experts and an interagency program board to advise on Landsat commercialization. In response to an inquiry from the private sector, these examinations were broadened to include concurrent commercialization of the meteorological satellite systems. In addition to these Executive Branch reviews, the 1982 legislation (P.L. 97-324) authorizing NOAA to operate the Landsat system required the Secretary of Commerce

to conduct a series of studies and report to the Congress. The submission date for the last report was April 1, 1983.

The Presidential decision announced on March 8, 1983, proposes to offer the Landsat system for sale to the private sector either separately or in conjunction with the civil meteorological satellite systems.

NASA Guidelines Regarding Early Usage of Space for Industrial Purposes

NASA, by virtue of the National Aeronautics and Space Act of 1958, is directed to conduct its activities so as to contribute to the preservation of the role of the United States as a leader in aeronautical and space science and technology and their applications.

Since substantial portions of the United States technological base and motivation reside in the United States private sector, NASA will enter into transactions and take necessary and proper actions to achieve the objective of national technological superiority through joint action with United States domestic concerns. These transactions and actions will be undertaken in the context of stated NASA program objectives and after a determination by the Administrator. They may include, but are not limited to: (1) engaging in joint arrangements with United States domestic concerns in research programs directed to the development or enhancement of United States commercial leadership utilizing the space environment; (2) conducting research programs having as an end objective the enhancement of United States capability by developing space-related high-risk or long-lead-time technology; and (3) by entering into transactions with United States concerns designed to encourage the commercial availability of products of NASA space flight systems.

NASA incentives for these purposes may include in addition to making available the results of NASA research: (1) providing flight time on the space transportation system on appropriate terms and conditions as determined by the Administrator; (2) providing technical advice, consultation, data, equipment and facilities to participating organizations; and (3) entering into joint research and demonstration programs where each party funds its own participation.

In making the necessary determination to proceed under this policy, the Administrator will consider the need for NASA funded

support to commercial endeavors and the relative benefits to be obtained from such endeavors.

As major areas for NASA enhancement of total United States capability, including the private sector, may become apparent from time to time, the factors to be considered by NASA prior to providing incentives may include, but not be limited to, some or all of the following considerations: (1) the public or social need for the expected technology development; (2) the contribution to be made to the maintenance of United States technological superiority; (3) possible benefits accruing to the public or the United States Government from sharing in results; (4) the enhanced economic exploitation of NASA capabilities such as the space transportation system; (5) the desirability of private sector involvement in NASA programs; (6) the merit of the research, development or application proposed; (7) the degree of risk and financial participation by the commercial concern; (8) the amount of proprietary data or background information to be furnished by the concern; (9) the rights in data to be granted the concern in consideration of its contribution; (10) the ability of the concern to project a potential market; (11) the willingness and ability of the concern to market and sell any resulting new or enhanced products on a reasonable basis; (12) the impact of NASA sponsorship on a given industry; (13) provision for a form of exclusivity in special cases when needed to promote innovation; (14) recoupment of the NASA contribution under appropriate circumstances; and (15) support of socio-economic objectives of the Government.

/S/Robert A. Frosch
Robert A. Frosch
Administrator

June 25, 1979
Date

NASA/Industry Working Relationships

NASA has developed three basic levels of working relationships with private organizations. These provide the flexibility needed to meet a wide range of needs from large organizations with strong research departments to small entrepreneurial firms that want to develop a product for the market. They also provide for incremental increases in understanding and commitment by the parties. In all cases, the Government does not fund any of the work done by the firm, but rather each party funds its own activities separately.

Joint Endeavor Agreement (JEA)

The JEA is a cooperative arrangement in which private participants and NASA share common program objectives, program responsibilities, and financial risk. The objective of a JEA is to encourage early space ventures and demonstrate the usefulness of space technology to meet marketplace needs. A JEA is a legal agreement between equal partners, and is not a procurement action; no funds are exchanged between NASA and the industrial partner. A private participant selects an experiment and/or technology demonstration for a joint endeavor which complies with MPS program objectives, conducts the necessary ground investigation, and develops flight hardware at company expense. As incentive for this investment, NASA agrees to provide free Shuttle flights for projects which meet certain basic criteria, such as technical merit, contribution to innovation, and acceptable business arrangements. As further incentive, the participant is allowed to retain certain proprietary rights to the results, particularly the nonpatentable information that yields a competitive edge in marketing products based on MPS results. However, NASA receives sufficient data to evaluate the significance of the results, and requires that any promising technologies be applied commercially on a timely basis, or published.

Technical Exchange Agreement (TEA)

For companies interested in applying microgravity technology,

but not ready to commit to a specific space flight experiment or venture, NASA has developed TEA. Under a TEA, NASA and a company agree to exchange technical information and cooperate in the conduct and analysis of ground-based research programs. In this agreement, a firm can become familiar with microgravity technology and its applicability to the company product line at minimal expense. Under TEA, the private company funds its own participation, and derives direct access to and results from NASA facilities and research, with NASA gaining the support and expertise of the private company's industrial research capability.

Industrial Guest Investigators (IGI)

In an IGI agreement, NASA and industry share sufficient mutual scientific interest that a company arranges for one of its scientists to collaborate (at company expense) with a NASA-sponsored principal investigator on a space flight MPS experiment. Once the parties agree to the contribution to be made to the objectives of the experiment, the IGI becomes a member of the investigation team, thus adding industrial expertise and insight to the experiment.

Protecting Intellectual Property in Space Activities

Gerald J. Mossinghoff, Assistant Secretary of Commerce and Commissioner of Patents and Trademarks

In this paper, I will discuss the arrangements which have been adopted by NASA to protect intellectual property in space endeavors.

Patent Provisions of the Space Act

In the climate that existed when the Space Act was enacted, Congress was reluctant to allow contractors of the new civilian agency to acquire rights to inventions made under contract without some safeguards to protect the public investment in this new and unknown area of technological activity. Thus, the patent provisions of the Space Act, which were agreed to by the U.S. House of Representatives and the Senate and which appear in section 305 of the Space Act,[1] attempted to strike a balance between the government's interest and the need to spur private initiative and innovation.

A basic tenet of section 305 is that all rights vest in the United States for any invention "made in the performance of any work under any contract" of NASA, unless all or part of such rights are waived by the Administrator of NASA. The statutory authority for granting waivers is very broad, requiring only that a determination be made that "the interests of the United States will be served" by such waiver.

NASA was mindful that flexibility was needed in implementing section 305 in order to encourage maximum industrial participation in its activities and the application of innovative technology to its programs. But it was faced with very little guidance on how to interpret the new section 305. It, thus, was confronted with two immediate issues: (1) the development of an appropriate waiver policy and (2) a reasonable interpretation of the types of contracts

to which the stringent title-vesting provisions of section 305 were to be applied.

As to the first issue, after less-than-satisfactory attempts to develop waiver criteria based on the type of technology involved, NASA helped to formulate and then adopted the government-wide Presidential Memorandum and Statement of Government Patent Policy of 1963[2] as a guide in specifying the criteria for waiver grant. Following this Memorandum and Statement, NASA's waiver regulations have since 1964 specified that waiver of commercial rights may be granted either at the time of contracting (for all inventions which may be made under the contract) or for an identified invention actually made and reported under contract, provided the requisite findings essentially as set forth in the Memorandum and Statement can be made.[3]

Overall, the NASA waiver process has been flexible. In instances where waiver of rights is requested, the percentage of grants in recent years has been very high, approximately 90%. And while the processing of waivers does involve some delays, NASA does not believe that there have been any harmful delays of procurement actions or patent filings.

In deciding the second issue—that is, the types of contracts subject to section 305 treatment—NASA has consistently made administrative interpretations that many agreements, understandings or arrangements were not "contracts" for the purposes of section 305. That term was construed as not applying, for example, to proposals submitted to NASA; contracts for supplies, construction or utility services; launch service agreements (where NASA provides services for another party on a reimbursable basis); use of NASA facilities (such as wind tunnels); use of satellite data; exchange of technical information and joint contributions of hardware to a common problem. An analysis of these activities indicates a common factor: they did not involve the performance of work of an inventive type for NASA. It has, therefore, been NASA's long-standing administrative interpretation of section 305 that the contracts, agreements, understandings or arrangements to which it applies are those for the performance of work of an inventive type (i.e., design, engineering, development, research or experimental work) *for* NASA. This interpretation, in turn, has per-

mitted NASA to be very flexible in dealing with patent rights as they relate to encouraging private commercial participation in space.

Rights in Technical Data

Rights to valuable technical, commercial and financial information (i.e., "data") are in some instances more important than patent rights when considering commercial participation in space. NASA's policies with respect to rights to data involved in contract performance are not subject to express statutory requirements as are rights to inventions made under contract. There are, however, collateral statutory provisions, such as section 203 (a) (3) of the Space Act and the Freedom of Information Act,[4] that must be considered in implementing and applying these policies.

As far as procurement contracts are concerned, including those contracts which may also be subject to section 305 regarding patent rights, it is NASA policy normally to acquire data first produced in the performance of the contract without restriction regarding its publication, use or disclosure, i.e., with "unlimited rights." It is also NASA policy not to acquire "protectible" data unless necessary, but, if necessary, to acquire data under express agreement or understanding not to use or disclose it in a manner that would compromise its value as an intellectual property right, i.e., to acquire it with limited or "restricted rights." Care is taken to agree to protect only that data (whether in a proposal, submitted under contract or pursuant to any other arrangement) which can be protected under law, but once agreed to, maximum protection is assured. However, in order to reduce administrative burdens and legal risks, as an overriding consideration it is NASA policy not to acquire protectible data unless there is a real need for it.

NASA's policies with respect to copyright subsisting in data produced under contract must be considered in conjunction with its data policies. As a general rule, permission from NASA is required for a contractor to assert or establish a claim to copyright subsisting in data first produced under contract. Such permission is (1) granted automatically at the time of contracting for scientific and technical articles based on work performed under contract and published in academic or technical journals and (2) granted liberally in other situations upon request.

Since NASA's policies regarding data rights and copyrights involved in contract performance are not subject to express statutory requirement as are invention rights, there is no need to make any distinction between those "contracts" that are subject to section 305 and those that are not for the purpose of considering such rights. Thus, as a practical matter NASA negotiates data rights and copyrights in non-procurement transactions to fit the circumstances. The only statutory precautions are to assure that agreements regarding such rights are consistent with section 203 (a) (3) of the Space Act and the Freedom of Information Act.

Commercial Activities in Space

As the Space Shuttle became a reality, both NASA and the private sector were well aware of its potential as a facility that could be made available for commercial activities. Obviously, it could replace expendable launch vehicles for placing free-flying payloads into orbit, e.g., geostationary communications satellites. But an even greater potential was created: the Shuttle and the contained Spacelab, developed by the European Space Agency, is a true spaceborne laboratory for the conduct of experiments, demonstrations or possibly ongoing commercial operations for processing materials in a zero-gravity, near-perfect vacuum environment.

There was an early appreciation that special policies had to be formulated if the vast potential that this new capability represented was to be realized. As a result, NASA conducted two significant studies: one to explore the legal and policy issues regarding joint programs with industry to bridge the gap between government-funded demonstrations and fully reimbursable commercial activities and one to explore the status of inventions under any gap-filler demonstrations if they were to be carried out.[5] The result of the first study was that NASA could enter into diverse and flexible arrangements (other than conventional procurement contracts) with the private sector as part of its statutory mandates. The result of the second study made it clear that when properly structured such arrangements were not "contracts" covered by section 305 (a) of the Space Act.

NASA's intent actively to encourage commercial participation in the space program is fully reflected in the 1979 *Guidelines Re-*

garding Joint Endeavors with U.S. Domestic Concerns in Materials Processing in Space. In general, a joint endeavor is an arrangement between NASA and a private party in which each undertakes to contribute to or participate in a project of mutual benefit. It usually involves the use of equipment, facilities, services, personnel or information made available by one of the parties for use by the other. Such endeavors do not involve the transfer of funds or title to property between the parties and are not considered procurement or assistance agreements. Services which may be involved do not constitute the employment of one of the parties' employees by the other.

Since it had been previously established that a joint endeavor, as thus defined, was not a "contract" subject to section 305 (a) of the Space Act, NASA was free to negotiate intellectual property rights in a manner consistent with the policy of encouraging active commercial participation in space. Since joint endeavors may vary in size, complexity and respective responsibilities of the parties, they are negotiated on a case-by-case basis. On one end of the spectrum, such as the demonstration of the feasibility of manufacturing capability in orbital flight, extensive negotiations of invention and data rights may be expected. As a general rule, the industry participant may retain rights to inventions and proprietary data produced in carrying out its responsibilties under the same joint endeavor, subject to certain contingent rights in NASA. These contingent rights are structured to assure access to the technology in the event the private participant cannot or does not carry out its responsibilities. Additional consideration is given to public needs in the area of health, safety and welfare if applicable, as well as the status of rights in the event of termination by either party. All in all, however, rights to inventions and know-how are a matter of negotiation, consistent with NASA's announced policy of providing incentives for early participation of the private sector in commercial use of space.[6]

On the other end of the spectrum joint endeavors may merely be technology exchange agreements. In this situation NASA and the industrial participant agree to exchange know-how relating to a particular activity. Usually each party agrees to provide to the other only that information which can be used and disclosed without restriction. If, however, "protectible information" is involved, NASA

may agree to receive such information in confidence and to use it only to the extent provided in the joint endeavor.

Overlaying NASA's policy regarding joint endeavors or any similar arrangements falling within the spectrum discussed above is NASA's policy to receive adequate information without restriction to comply with its responsibilities under section 203 (a) (3) of the Space Act, but to respect privately funded rights. NASA may pay particular attention to the Freedom of Information Act and court decisions regarding the protection of intellectual property rights to any data furnished to the government. Thus, in any joint endeavor or similar arrangement there usually is a positive statement as to that data which NASA will receive without restriction on its use or disclosure. Beyond that, there is clear understanding as to NASA's rights and obligations regarding any "protectible" data that may be furnished to NASA, structured in a manner to provide maximum protection to the private party. The requirement for access to this latter type of data is kept to a minimum, and if it is needed it is received in confidence and used only to the extent necessary for NASA to carry out its responsibilities under the joint endeavor, unless the contingent rights are exercised.

Implications for the Future

A review of NASA's policies, practices and procedures in the area of intellectual property rights indicates a firm policy decision to provide incentives for the private sector to become involved in innovative transactions, such as joint endeavors, for the commercial use of space. NASA has had a history, since it initially had to make reasoned judgments in implementing section 305 of the Space Act, of being extremely flexible yet realistic in protecting private interests and of keeping private incentive and initiative at a high level. The innovative approaches applied to joint endeavors for commercial use of space demonstrate a logical extension of that history. Obviously, in addition to joint endeavors of the type discussed there is a range of similar arrangements which may be entered into with the private sector for commercial use of space, consistent with the policies and objectives of the Space Act. As far as intellectual property rights are concerned, the stage has been set and precedent well established for NASA to negotiate

such rights in a manner wholly consistent with these policies and objectives.

Strong legal protection for the results of private ventures in space is essential if such ventures are to flourish. NASA has recognized this and has formulated its policies accordingly.

Appendix Five Notes

1. The relevant portions of section 305 read as follows:

"SEC. 305. (a) Whenever any invention is made in the performance of any work under contract of the Administration, and the Administrator determines that—

(1) the person who made the invention was employed or assigned to perform research, development, or exploration work and the invention is related to the work he was employed or assigned to perform, or that it was within the scope of his employment duties, whether or not it was made during working hours, or with a contribution by the government of the use of government facilities, equipment, materials, allocated funds, information proprietary to the government, or services of government employees during working hours; or

(2) the person who made the invention was not employed or assigned to perform research, development, or exploration work, but the invention is nevertheless related to the contract, or to the work or duties he was employed or assigned to perform, and was made during working hours, or with a contribution from the government of the sort referred to in clause (1),

such invention shall be the exclusive property of the United States, and if such invention is patentable a patent therefor shall be issued to the United States upon application made by the Administrator, unless the Administrator waives all or any part of the rights of the United States to such invention in conformity with the provisions of subsection (f) of this section.

"(f) Under such regulations in conformity with this subsection as the Administrator shall prescribe, he may waive all or any part of the rights of the United States under this section with respect to any invention or class of persons in the performance of any work required by any contract of the Administration if the Administrator determines that the interest of the United States will be served thereby. Any such waiver may be made upon such terms and under such conditions as the Administrator shall determine to be required for the protection of the interests of the United States. Each such waiver made with respect to any invention shall be subject to the reservation by the Administrator of an irrevocable, nonexclusive, nontransferrable, royalty-free license for the practice of such invention throughout the world by or on behalf of the United States or any foreign government pursuant to any treaty or agreement with the United States. Each proposal for any waiver under this subsection shall be referred to an Inventions and Contributions Board which shall be established by the Administrator within the Administration. Such a Board shall accord to each interested party an opportunity for hearing, and shall transmit to the Administrator its findings of fact with respect to such proposal and its recommendations for action to be taken with respect thereto.

"(j) As used in this section—

(1) the term "person" means any individual, partnership, corporation, association, institution, or other entity;

(2) the term "contract" means any actual or proposed contract, agreement, understanding, or other arrangement, and includes any assignment, substitution of parties, or subcontract executed or entered into thereunder; and

(3) the term "made," when used in relation to any invention means the conception or first actual reduction to practice of such invention.

2. The 1963 Memorandum was replaced by a 1971 Presidential Memorandum which differed only in detail from the earlier memorandum. Each of these has now been superseded by a

Memorandum from the President on Federal Patent Policy dated February 18, 1983. That new policy provides:

> "To the extent permitted by law, agency policy with respect to the disposition of any invention made in the performance of a Federally funded research and development contract, grant or cooperative agreement award shall be the same or substantially the same as applied to small business firms and nonprofit organizations under chapter 38 of title 35 of the United States Code."

Chapter 38 of title 35 in general created a presumption that the contractor shall have the first right of refusal of commercial rights to an invention made under a government contract.

3. NASA Patent Waiver Regulations, 14 CFR, section 1245, subpart 1. Section 305 (f) also requires that any waiver which is granted, "shall be subject to the reservation of an irrevocable, nonexclusive, nontransferrable, royalty-free license for the practice of such invention throughout the world by or on behalf of the United States or any foreign government pursuant to any treaty or agreement with the United States." The Presidential Memorandum and Statement also provide that agencies usually are to retain similar rights, as well as rights of essentially the same scope, for states and domestic municipal governments. In addition, the Memorandum and Statement reserve to the government certain directed licensing rights (so-called "march-in" rights) to assure commercialization of the invention, and to assure availability to meet public health, safety and government regulatory needs. These license rights and march-in rights have been adopted in the NASA waiver regulations.

4. Section 203 (a) (3) provides that:

> "(a) The Administration, in order to carry out the purpose of this Act shall–
> "(3) provide for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof."
> The Freedom of Information Act, title 5, United States Code,

section 552, requires government agencies to release to any requestor agency records unless they fall under nine specific exemptions. One of those exemptions (section 552 (b) (4)) relates to trade secrets and confidential business information.

5. The results of the second study are reprinted as Appendix G in the article "Intellectual Property Rights in Space Ventures," by the author, published in Volume 10, *Journal of Space Law*, page 122 (1982).

6. The proprietary rights in inventions clauses of an early joint venture are published in full in Appendix F of the article cited in footnote 5 supra. That joint venture was between NASA and McDonnell Douglas Astronautics Company ("MDAC") and concerned materials processing in space. Relevant portions of the "Property Rights in Inventions" article read as follows:

"A. . . . MDAC-St. Louis and any party in privity therewith shall retain all right, title and interest to any invention conceived or first actually reduced to practice in carrying out its responsibilities under this agreement as described in Article II of this Agreement.

"B. With respect to any invention subject to paragraph A above, the following will apply:

1. NASA shall have a contingent royalty-free license to practice or have practiced in a space environment only, such inventions by or on behalf of the government for any government purpose. The contingent royalty-free license is a nonexclusive paid-up license to all inventions contained in paragraph A above, and all data and patents necessary to practice or have practiced such inventions in space, which data will be furnished to NASA, and will become effective if the NASA Administrator or his/her designee determines such action is necessary, (i) because MDAC-St. Louis or any party in privity therewith has not taken, or is not expected to take within a reasonable time, effective steps to achieve commercial utilization of the invention; or (ii) in response to a national emergency involving a

serious threat to the public health and upon showing that (a) no competitive alternative to the subject matter covered by the patent is reasonably available from other sources and (b) MDAC-St. Louis or its parties in privity are not supplying the subject matter covered by the patent in sufficient quantity and at reasonable prices to satisfy market needs; or (iii) in event of a unilateral termination by MDAC-St. Louis. . . .

2. If a determination is made by the NASA administrator or his/her designee that action is necessary as a result of (i) or (ii) in paragraph B1 above, NASA has the right to require the granting of a license to responsible parties, upon terms and conditions reasonable under the circumstances, or to so grant such a license itself, if in the judgment of the NASA Administrator or his/her designee that MDAC-St. Louis or its parties in privity have not effectively taken steps or have been unsuccessful in licensing to satisfy the requirements of (i) and (ii) above.

"C. Prior to the making of a determination by the NASA Administrator or his/her designee under paragraph B above, NASA's Associate Administrator, Office of Space and Terrestrial Applications, shall give MDAC-St. Louis sixty days' written notice of intention to make such determination and provide findings in support thereof and shall afford MDAC-St. Louis an opportunity to be heard and offer evidence in support of its position. Any determination will be subject to Article XXV, "Disputes."

"D. MDAC-St. Louis shall, at the request of NASA, provide NASA with a brief description of any invention subject to paragraph A above, and of any action taken to obtain patent protection thereon, and of the final disposition of such action. Any brief description so provided shall be subject to protection from disclosure under the provisions of paragraph C of Article VIII, "Data Rights" until a patent is issued thereon or the patent application is otherwise made available to the public."

Excerpts from Treaties Governing Space Activities

This appendix sets forth selected provisions of four treaties which place responsibilities on the United States in the conduct of space activities and the utilization of outer space. These provisions are cited to provide a better understanding of United States treaty obligations which necessitate an orderly regulatory process.

Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies

(October 10, 1967)

Article I

The exploration and use of outer space, including the moon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all mankind.

Article II

Outer space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means.

Article III

States Parties to the Treaty shall carry on activities in the exploration and use of outer space, including the moon and other celestial bodies, in accordance with international law, including the Charter of the United Nations, in the interest of maintaining international peace and security and promoting international cooperation and understanding.

Article IV

States Parties to the Treaty undertake not to place in orbit around the Earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction, install such weapons on celestial bodies, or station such weapons in outer space in any other manner.

Article VI

States Parties to the Treaty shall bear international responsibility for national activities in outer space, including the moon and other celestial bodies, whether such activities are carried on by governmental agencies or by non-governmental entities, and for assuring that national activities are carried out in conformity with the provisions set forth in the present Treaty. The activities of non-governmental entities in outer space, including the moon and other celestial bodies, shall require authorization and continuing supervision by the appropriate State Party to the Treaty. When activities are carried on in outer space, including the moon and other celestial bodies, by an international organization, responsibility for compliance with this Treaty shall be borne both by the international organization and by the States Parties to the Treaty participating in such organization.

Article VII

Each State Party to the Treaty that launches or procures the launching of an object into outer space, including the moon and other celestial bodies, and each State Party from whose territory or facility an object is launched, is internationally liable for damage to another State Party to the Treaty or to its natural or juridical persons by such object or its component parts on the Earth, in air space or in outer space, including the moon and other celestial bodies.

Article IX

In the exploration and use of outer space, including the moon and other celestial bodies, States Parties to the Treaty shall be guided by the principle of co-operation and mutual assistance and shall conduct all their activities in outer space, including the moon and other celestial bodies, with due regard to the corresponding interest of all other States Parties to the Treaty. States Parties to

the Treaty shall pursue studies of outer space, including the moon and other celestial bodies, and conduct exploration of them so as to avoid their harmful contamination and also adverse changes in the environment of the Earth, resulting from the introduction of extraterrestrial matter and, where necessary, shall adopt appropriate measures for this purpose. If a State Party to the Treaty has reason to believe that an activity or experiment planned by it or its nationals in outer space, including the moon and other celestial bodies, would cause potentially harmful interference with activities of other State Parties in the peaceful exploration and use of outer space, including the moon and other celestial bodies, it shall undertake appropriate international consultations before proceeding with any such activity or experiment. A State Party to the Treaty which has reason to believe that an activity or experiment planned by another State Party in outer space, including the moon and other celestial bodies, would cause potentially harmful interference with activities in the peaceful exploration and use of outer space, including the moon and other celestial bodies, may request consultation concerning the activity or experiment.

Article X

In order to promote international co-operation in the exploration and use of outer space, including the moon and other celestial bodies, in conformity with the purpose of this Treaty, the States Parties to the Treaty shall consider on a basis of equality any requests by other States Parties to the Treaty to be afforded an opportunity to observe the flight of space objects launched by those States.

The nature of such an opportunity for observation and the conditions under which it could be afforded shall be determined by agreement between the States concerned.

Article XI

In order to promote international co-operation in the peaceful exploration and use of outer space, States Parties to the Treaty conducting activities in outer space, including the moon and other celestial bodies, agree to inform the Secretary-General of the United Nations as well as the public and the international scientific community, to the greatest extent feasible and practicable, of the na-

ture, conduct, locations and results of such activities. On receiving the said information, the Secretary-General of the United Nations should be prepared to disseminate it immediately and effectively.

Convention on International Liability for Damage Caused By Space Objects

(October 9, 1973)

Article I

For the purposes of this Convention:

(a) The term "damage" means loss of life, personal injury or other impairment of health; or loss of or damage to property of States or of persons, natural or juridical, or property of international intergovernmental organizations;

(b) The term "launching" includes attempted launching;

(c) The term "launching State" means:

(i) A State which launches or procures the launching of a space object;

(ii) A State from whose territory or facility a space object is launched;

(d) The term "space object" includes component parts of a space object as well as its launch vehicle and parts thereof.

Article II

A launching State shall be absolutely liable to pay compensation for damage caused by its space object on the surface of the earth or to aircraft in flight.

Convention on Registration of Objects Launched Into Outer Space

(Sept. 15, 1976)

Article I

For the purposes of this Convention:

(a) The term "launching State" means:

(i) A State which launches or procures the launching of a space object;

(ii) A State from whose territory or facility a space object is launched;

(b) The term "space object" includes component parts of a space object as well as its launch vehicles and parts thereof;

(c) The term "State of registry" means a launching State on whose registry a space object is carried in accordance with article II.

Article II

1. When a space object is launched into earth orbit or beyond, the launching State shall register the space object by means of an entry in an appropriate registry which it shall maintain. Each launching state shall inform the Secretary-General of the United Nations of the establishment of such a registry.

2. Where there are two or more launching States in respect of any such space object, they shall jointly determine which one of them shall register the object in accordance with paragraph 1 of this article, . . .

3. The contents of each registry and the conditions under which it is maintained shall be determined by the State of registry concerned.

Article III

1. The Secretary-General of the United Nations shall maintain a Register in which the information furnished in accordance with article IV shall be recorded.

2. There shall be full and open access to the information in this Register.

Article IV

1. Each State of registry shall furnish to the Secretary-General of the United Nations, as soon as practicable, the following information concerning each space object carried on its registry;

(a) Name of launching State or States;

(b) An appropriate designator of the space object or its registration number;

(c) Date and territory or location of launch;

(d) Basic orbital parameters, including:

(i) Nodal period,
(ii) Inclination,
(iii) Apogee,
(iv) Perigee;

(e) General function of the space object.

2. Each State of registry may, from time to time, provide the Secretary-General of the United Nations with additional information concerning a space object carried on its registry.

3. Each State of registry shall notify the Secretary-General of the United Nations, to the greatest extent feasible and as soon as practicable, of space objects concerning which it has previously transmitted information, and which have been but no longer are in earth orbit.

Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques

(Ratified by United States Jan. 17, 1980)

Article I

1. Each State Party to this Convention undertakes not to engage in military or any other hostile use of environmental modification techniques having widespread, long-lasting or severe effects as the means of destruction, damage or injury to any other State Party.

2. Each State Party to this Convention undertakes not to assist, encourage or induce any State, group of States or international organization to engage in activities contrary to the provisions of paragraph 1 of this article.

Article II

As used in article 1, the term "environmental modification techniques" refers to any technique for changing—through the deliberate manipulation of natural processes—the dynamics, composition or structure of the earth, including its biota, lithosphere, hydrosphere and atmosphere, or of outer space.

Article III

1. The provisions of this Convention shall not hinder the use

of environmental modification techniques for peaceful purposes and shall be without prejudice to the generally recognized principles and applicable rules of international law concerning such use.

Article IV

Each State Party to this Convention undertakes to take any measures it considers necessary in accordance with its constitutional processes to prohibit and prevent any activity in violation of the provisions of the Convention anywhere under its jurisdiction or control.

Testimony of Philip M. Klutznick before the Subcommittee on Space Science and Applications U.S. House of Representatives

Mr. Chairman and Members of the Subcommittee:

It is a privilege to appear before you today as Chairman of the National Academy of Public Administration Panel on Encouraging Business Ventures in Space Technologies. The Panel was formed in response to a request from the Administrator of the National Aeronautics and Space Administration (NASA) to study and recommend policies and approaches designed to facilitate private sector involvement and investment in commercial activities in space. Joining with me today are fellow Panel members Vice Chairman Mitchell Rogovin, and Gerald Mossinghoff. Also at this time I would like to acknowledge the contributions of our other Panel members: Stover Babcock, Richard Bolt, Samuel Cohn, Emilio Daddario, Harold Finger, Peter Goldmark, John Johnson, and Thomas Paine.

Mr. Chairman, with your permission I submit for the hearing record a complete copy of the Panel's report which was presented to the Administrator on May 2, 1983. I will make some brief observations. I suggest that an opportunity be provided for my colleagues to comment. Thereafter, we are prepared to respond to your questions.

The United States has been in the space business for approximately twenty-five years. During this period the nation has developed a comprehensive space research and technology base in government, in industry and in our universities. Our total capabilities have been demonstrated in manned Apollo missions to the moon, in unmanned science missions to the planets and in meteorological, communications and other applications satellite technologies. Except for the commercial satellite communications industry which established itself after initial NASA R&D efforts, U.S. activities in space have been characterized almost exclusively by government objec-

tives and government funding. In recent months, however, there has been an upsurge of interest in the private sector in commercial space ventures. This is evidenced by various proposals submitted to NASA and by several ventures initiated independent of NASA. We cannot catalogue all the reasons for this private sector interest in space activity; it may be due in part to the advent of the space shuttle with its successful flight program offering a new and unique capability to use and explore the space environment, or it may result from an increasing awareness of profitable opportunities in and the importance of high technology enterprises. This interest has parallels abroad, particularly in Japan, France and Germany.

On the eve of this hearing, the April 19th issue of the *New York Times* carried a front page story in its "Business Day" section regarding the formation of the Orbital Systems Corporation by three young men 30 years of age and younger. It is stated that they borrowed their capital from banks, private investors and financial institutions, including the Space Foundation of Houston. These entrepreneurs announced that they had "negotiated a deal with NASA to develop and market a privately financed propulsion system to boost communications satellites and other payloads from the space shuttle's low orbit to higher altitudes."

Mr. Chairman, it is too early to forecast the degree of success private ventures in space technology will achieve. Communications satellites represent a major growth industry. At this time this industry is the principal example of a successful commercial application of space technology. Nevertheless, its success strongly supports the proposition that the nation should make a coordinated effort to test the commercial potential of all space technologies and the space environment. The Panel makes no predictions as to the total benefits that might accrue from a commercialization thrust. Such estimates would be accompanied by great uncertainty. The Panel is convinced, however, that the space arena should be carefully and thoroughly examined by the business community so that, as a nation, we do not overlook an opportunity for economic benefit. Furthermore, the involvement of the private sector is essential to maintain U.S. leadership in space—an explicit national objective set forth in the National Aeronautics and Space Act of 1958. This objective was reaffirmed in the President's Space Policy Statement released July 4, 1982.

NASA has been and for some time will continue to be the principal generator of space technology. This role is a statutory obligation of the agency and one that has been performed extremely well. In so doing, there has been created an internal organizational philosophy and an external image that space is largely a governmental function. If the United States is to pursue the economic potential of space, NASA must play a key facilitating role—a role that is new to the agency but complementary to its continuing statutory responsibilities. These factors lead to the Panel's recommendation that there must be a clear statement of senior management commitment and a positive program in support of commercialization as a policy compatible with the long-run future of NASA. This statement should be disseminated widely within NASA, to industry and to the general public.

The Panel believes that a commercialization role does not diminish the NASA R&D role; it strengthens it and provides additional challenges. NASA is the basic source of space technology, space systems, and knowledge of the space environment, all of which are essential to support commercial endeavors in space. While industry excels in exploiting and marketing current technology, it often does not have the resources to undertake the high risk, long term advanced developments necessary to maintain a leadership posture in an increasingly competitive international market. A case in point is the advanced satellite communications program in the NASA FY-1984 budget request. The Panel believes that the continuing R&D role for NASA is vital if we are to identify new opportunities such as may exist in materials processing in space (MPS). For example, the NASA/McDonnell Douglas/Johnson and Johnson joint endeavor in electrophroresis, an experiment on the STS-6 flight, is based upon initial research performed by NASA. MPS appears to hold a large potential for economic benefit. The Panel recommends that NASA give more attention to this activity.

In addition, Mr. Chairman, there are major facilities, perhaps best exemplified by the development of the space shuttle, that are multi-user, very expensive and technically complex, and that are critical to utilization of the space environment. These developments transcend the capabilities and needs of individual private sector firms. The Panel believes we should apply national facility precedents from the NASA aeronautical wind tunnel program to the

development, utilization and operation of major facilities in space. We view the NASA R&D role and a concurrent commercialization thrust in the agency as mutually supportive for national goals and for economic benefit. The validity of this view is evidenced by the recognized benefits accruing from extensive NASA/industry collaboration in aeronautical research activities.

Most space endeavors are recognized as high risk, expensive and long lead time activities. These factors must be addressed if the private sector is to become involved. Technical risk can be reduced to more manageable levels through continuing NASA R&D activities that pursue new initiatives through technology demonstration. The expense of experimentation in the space environment can be reduced through the use of the joint endeavor agreement. Also, NASA works closely with the insurance industry to assure available coverages for risk taking. The Panel notes the NASA awareness of these inhibiting factors and that the agency has taken positive steps to address them. Such affirmative efforts have to be made continuously. Finally, stability, consistency and continuity of policy are essential to promote business enterprise. NASA's commercialization policies must recognize the importance of these factors and the agency must strive to minimize disruptions.

Perhaps the most difficult chore the Panel has identified to NASA is educating industry in space technologies and encouraging industry participation in commercial initiatives. Industry, particularly non-aerospace companies that daily produce goods and services for domestic and international markets, has to be made aware of the potential of space technology. Many of these firms will be exposed for the first time to the technological sophistication of space endeavors. NASA has developed innovative mechanisms – the industrial guest investigator program (IGI) and the technical exchange agreement (TEA) to address this need. Early familiarity with NASA R&D projects enables initial assessments of commercial potentials and enhances planning for eventual commercial applications. The Panel considers the IGI and TEA as effective approaches to this problem and their use should be expanded. In addition to these mechanisms at the technical level, it is also necessary to begin a dialogue with those industry management personnel with responsibility for strategic business planning.

Mr. Chairman, organization for the commercialization activity

is vital to achieving success. NASA has a challenging problem because of its program office structure and its appropriate concentration on scientific and technical objectives. This structure has been splendidly effective in producing the many NASA accomplishments. However, the Panel found a large amount of fragmentation of present commercialization activities within the agency that are counterproductive. In fact, many outsiders, and some NASA personnel, do not know where to go to discuss commercial endeavors. Therefore, the Panel recommends the establishment of a well defined focus of responsibility at a high level in NASA to address the commercialization role. The report identifies functions associated with this responsibility. Implicit in our recommendation, however, is a low key approach; we are not suggesting a major reorganization of NASA. Rather we believe it is important to clearly establish the focal point and then gradually pull together appropriate organizational elements, building a cohesive unit as the agency moves ahead with its commercialization role. The Panel does stress the need for the leadership of this activity to have business decision-making and marketplace experience.

In Section X of the report the Panel has provided guidelines for use in processing proposals for commercial endeavors received by NASA. These were formulated in response to a specific request from the agency.

A word of caution as I conclude, Mr. Chairman. The Panel does not view its recommendations as requiring a significant infusion of federal funds. Our recommendations are to organize for a more efficient use of existing resources. Commercialization will require a government/industry partnership approach in which the private sector is expected to place capital at risk.

In addition to its homework, the Panel met on four occasions for a total of six working days to discuss these matters. During three meetings, there was extensive interaction with Mr. Beggs and senior NASA officials comprising a task force appointed for this specific purpose. Accordingly, NASA top management is quite familiar with our work and our recommendations. In one session, we met with seven entrepreneurs who are engaged in or are proposing business ventures in the commercialization of space technology to gain an understanding of their problems and concerns.

Mr. Chairman, I have presented a summary of the highlights

of our activity. In the event I have overlooked any significant points during this brief presentation, after my colleagues have expressed their views we would be pleased to try to respond to any questions.

Thank you.

—Philip M. Klutznick
Chairman
National Academy of Public Administration Panel

Statement of James M. Beggs before the Subcommittee on Space Science and Applications Committee on Science and Technology U.S. House of Representatives

Mr. Chairman and Members of the Subcommittee:

Mr. Chairman, it is a special pleasure for me to appear before this Subcommittee to participate in this series of Hearings on commercial activities in space. These Hearings represent a significant milestone in this Nation's space program. They are noteworthy in that the question being addressed today is no longer whether space has commercial promise but rather how best to proceed to maximize that promise for national economic well-being. In addition, they are timely because of the substantial interest expressed in commercialization by a number of industries. I have felt for some time that NASA should increase its attention to providing greater opportunities for private sector investment and operations in space in the same way that we, and our predecessor organization, the National Advisory Committee for Aeronautics, have provided that opportunity for the aeronautical interests in this country.

Shortly after the release of the President's July 4, 1982, National Space Policy Statement, which, in part, calls for the encouragement of domestic commercial exploitation of space capabilities, I asked the National Academy of Public Administration to undertake a study and make recommendations as to how best to engage the creative skills and enterpreneural initiative of the Nation's private sector in the commercialization of space. At the same time, I asked the Academy to examine the proper role of NASA in this arena.

Before giving you my observations on the Academy report, I would like to first express my deep appreciation to the Academy and in particular to Mr. Klutznick and other members of the Academy Panel who undertook this challenging task and did it so well.

The guidelines and recommendations formulated by the Panel

were requested by NASA to help us deal effectively and properly with the various initiatives presented to us by industry. During the course of the study, the panel had a number of meetings with NASA management and with representatives from the industry who have expressed an interest in the commercial possibilities of space activities. I have discussed the observations and recommendations reached during the study with the panel members during the course of the study. I also expect the guidelines will be helpful to business firms contemplating a space endeavor.

Mr. Chairman, a clear message from the Academy report is that the United States, after years of building a technology base second to none, should not fail to examine fully the potential for commercial enterprise in space. A second message is the need for government/industry cooperation to make this happen. I fully agree with these views.

The Panel recognizes NASA's statutory role in research and development and the importance of NASA R&D to commercial endeavors in space. The question we must ask ourselves is how we can most effectively continue this role and integrate a conscious and meaningful effort to support commercial potentials.

Mr. Chairman, the Panel has pointed out that space endeavors by their very nature are high risk, expensive and long lead time activities. Stability, consistency, and continuity in policies are essential to business decisions. As a former member of that business community I am keenly aware of the significance of stability in policy. From my present position in the government I am equally aware of the difficulty in assuring that long-lead stability. In our relationships with industry and in formulating our policies we must seek ways to provide reasonable assurances and to be prepared to participate in an active and positive way in those areas impacting commercialization where other organizations are involved.

Commercialization is not new to NASA. The satellite communications industry grew out of early work by NASA. The spinning upper stages used in the Shuttle were developed under a joint agreement between NASA and McDonnell Douglas Corporation. Our experience has clearly been limited, however. Today the items we have been discussing represent quite a menu of opportunities in many different types of initiatives. We have started to develop criteria by which to evaluate these new ideas, to develop a proper govern-

ment response to proposals, and to examine management and organizational approaches to assuring that the responsibilities of the government are properly carried out.

We also recognize the general unfamiliarity of the non-aerospace industry with space technology and space environment, and the importance of NASA facilities and associated hardware to the utilization of the space environment and to ameliorate somewhat the expense associated with entry of the private sector into this environment. We have taken an initial step through the Joint Endeavor Agreement approach to reduce the cost of using the Space Shuttle for commercial product research and experimentation purposes. We will look at our wind tunnel policies to determine what we can adapt from these policies regarding the use of other NASA facilities and hardware so as to facilitate and enhance the value of these facilities for U.S. industrial research activities.

NASA has made a start, as noted by the Panel, with Joint Endeavor Agreements and other cooperative arrangements to establish a two-way street with industry to identify potential opportunities, to expose our people to industry interests and requirements, and to support commercial ventures. We agree with the importance of developing this relationship with industry and will seek ways to enhance the process.

We must, however, proceed with caution as we enter into this relatively new arena. Although I have indicated, I wholeheartedly believe that the time has come to encourage and support expansion of commercial involvement in space activities, it is imperative that we develop sound guidelines by which this expansion takes place. We cannot ignore the fact that the American taxpayer has invested many billions of dollars in the knowledge and capability represented by today's space program. Nor can we proceed in ways which jeopardize the commitments and obligations that the government has in space programs—commitments that derive from the long legislative history within which NASA operates. We must also deal with these issues in a balanced manner which assures adequate opportunity for all reasonable approaches by the private sector providing those approaches comply with a sound and logical set of guidelines. We are, in taking these steps, establishing precedents which could profoundly affect the civil space program in years to come.

We must face the challenge in a way which will assure that the best use is made of the opportunity which it represents.

Finally, let me address a major issue now facing the Agency – the commercialization of expendable launch vehicles. Various proposals have been made to operate the Delta, Atlas-Centaur, and Titan vehicles on a commercial basis. We have reviewed this issue within NASA and have participated in the Senior Interagency Group (Space) study. These reviews will be concluded later this year. Many issues must be considered in the decision to commercialize ELVs, including: national security considerations, existing commitments, and issues associated with the use of national launch facilities. While I cannot, at this point, state what the outcome of these studies will be with respect to ELV commercialization, I see no reason, from a national policy standpoint, why such an activity cannot go forward.

Mr. Chairman, these are my views regarding the Academy study and our intentions regarding the implementation of its recommendations. I will be pleased to respond to your questions.

–James M. Beggs
Administrator
National Aeronautics and Space Administration

Statement of Daniel J. Fink before the Subcommittee on Space Science and Applications Committee on Science and Technology U.S. House of Representatives

Mr. Chairman and members of the Committee: It is a great personal pleasure for me to appear before this distinguished Subcommittee to comment on the commercialization of space and the role of the private and public sectors. The subject is important, timely, and one that I have been personally interested in for a number of years. My comments today are based on my understanding of past commercialization efforts, both from my own participation and from observations of the successes (and some failures) of others. While I currently chair the NASA Advisory Council, these views do not necessarily represent the Council, which has not specifically addressed this issue and therefore takes no position. On the other hand, we do have presently underway two Task Forces, one dealing with the future missions of NASA and the other with Shuttle utilization. Both may touch on some aspects of the subject at hand. When completed, this work will certainly be available to the Subcommittee.

The National Academy of Public Administration (NAPA) report is an excellent baseline on which to initiate these hearings. It recognizes a number of factors which I believe bear repetition. First, that we in this country have perhaps a unique opportunity to maintain our leadership in space if we can truly tap the additional contributions that can be made by the private sector. Second, that many facilitating steps must occur to make this happen. Third, that in the foreseeable future private space ventures will not be laissez faire activities; the government will interact on many levels. Finally, the report emphasizes the unique role the govern-

ment must continue to play in advancing the state of the art and in carrying out the longer term and more ambitious endeavors which will be required to continue our international space

In short, like other thoughtful treatments of the subject, it discusses a blend of free enterprise and public/private cooperation that is not the norm in our way of doing business. In the time available to me I'd like to make just a few additional and perhaps amplifying points.

To me free enterprise implies both the element of choice on the part of the private sector and the expectation that they will take the initiative in trading risk for reward. I would call that private initiative, as it applies to space endeavors, "commercialization pull." When we have it, success normally follows closely in its wake. The first commercial proposition for a communications satellite appeared in 1961. No undue prodding by the government was required. Rather., the government responded admirably to that commercial suction. Contrast this with remote sensing, where commercialization "push" by some parts of the government started, as I recall, in the mid-70s. I believe such commercialization "push" can be counterproductive to the progress we all want to see made. It certainly has been frustrating to the Congress. Some elements of the government behave as though their statements on commercialization are now fact, expecting the private sector to rush in and fill the breech. This has yet to happen because the interested private parties see the government as the principal customer for the product, but this customer makes no quantitative commitment to this fact. Perhaps we should recognize that, when the government is the principal or sole customer for a product or service, commercialization may offer some private sector efficiencies but it is really not the entrepreneurial engine that we all look to for expansion of our space endeavors. At times it may be little more than an alternate form of contracting or funding and should be recognized as such.

I would rather that we concentrated our attention on those areas more representative of free enterprise where there is commercialization "pull"; i.e., where the private sector is initiating activity and the government is gearing to respond. This is now happening in launch vehicles and launch services and I hope will be increas-

ingly evident in materials processing in space as initial successes are publicized and understood. There seems to be little argument that such commercialization is a good thing and should be encouraged. But verbal encouragement and pats on the back are not enough. Positive statements and policies issued at high levels, while important, are not sufficient. As a recent corporate strategic planner, I know that the best plan is worthless if it lacks an implementation program. Healthy industries have competing demands for their investment dollars. Those opportunities with unresolved uncertainties and risks that are seemingly not controllable will simply be sacrificed for those with a more certain return. It is not that industry will not take risks, but far better the business risk that intelligent application of their own effort and capital might ameliorate than the risk of a government, no matter how well intended, changing its mind.

It is vitally important that the policies now being developed to encourage commercialization be translated into actionable events by officials responsible for implementation. This is not a trivial statement because often these officials are many layers from the Agency heads and are more used to the adversary contractual process than the cooperative efforts now demanded. Perhaps if we were operating in an international vacuum this wouldn't be so important. But this Subcommittee needs little reminder of the overseas competition that has now extended into the space arena nor of the strength of governments and industries working together.

It is not my intent to develop a complete list of uncertainties that will need resolution, but included should be questions of government restraints on access to the market; controls on pricing, if any; and a much better understanding of the implications of national security overrides and their senstivity to policy changes. There may be need for restraints on the government which proscribe them from future competition with the private entity and limit international agreements which create overseas competition. The costs of regulation must be understood and, most important, early negotiations are required on the costs of government facilities and services needed by the private sector with some guarantee of their stability over time. Other implementation requirements are included in the NAPA report, including rights in inventions, insurance, etc. If these

issues are handled in a business-like manner, I am very optimistic that there will be increasing private involvement in space activities, particularly where there is already commercialization pull, such as in the provision of launch services through expendable launch vehicles (ELVs).

We must also recognize the implications this will have for the space transportation system and the manner in which the Shuttle is used. The NAPA report recommends against commercial operation of the Shuttle at this time because, in their view, it has not yet attained technical maturity. There is another reason for not rushing into Shuttle commercialization. If the commercial ELVs are successful, then by definition there will be some unloading of the Shuttle manifest. Rather than being discouraged by this event, I would be encouraged by the impetus this should give to both military and civilian use of the Shuttle in research and development. In my view such use has been inhibited because any R & D planner looking ahead could see the Shuttle fully utilized as a space truck with no U.S. alternative to Shuttle launching. He further faced the recognition that priority must be given to maintaining the military and commercial schedules with little room for far-reaching programs that might use the unique properties of the Shuttle: its size, the use of man, and its servicing and retrieving capabilities. This then is another reason for not prematurely commercializing Shuttle operations. It has too many other values to the nation.

In summary, Mr. Chairman, I believe the United States has a unique opportunity to extend its leadership in space technology, science, exploration and applicatons through proper exploitation of government responsibilities and private sector initiatives. Clearly the public policies are moving in this direction. My principle caution is that we recognize the complexity of the path on which we are embarking; that policy statements, while required, are not sufficient for success and that much attention must be paid by all parties, private and public, in implementing the policies if we are to succeed. The importance of this endeavor to our nation is admirably expressed in the closing paragraph of the NAPA report foreword.

> At a time when our nation has suffered losses in areas of technological creativity where it was once the undisputed leader, the space program has provided a compensating stimulant, the

tempo of which must not be lost. The prospect for business ventures in space technologies represents a major opportunity to demonstrate that within the free enterprise philosophy there is a great potential for cooperative endeavor between the public and private sector. Pursuit of this opportunity could become a model for joint public/private efforts in other areas.

Thank you, Mr. Chairman.

—Daniel J. Fink
Chair
NASA Advisory Council